

A HISTORY OF THE U.S. NAVY PHYSICAL READINESS PROGRAM FROM 1976 TO 1999

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LIST OF ACRONYMS

American Alliance for Health, Physical Education, Recreation and Dance	AAHPERD
American College of Sports Medicine	ACSM
Body Composition, Nutrition, and Health	BCNH
Body Mass Index	BMI
Bureau of Medicine	BUMED
Bureau of Personnel	BUPERS
Chief of Naval Operations	CNO
Command Fitness Coordinators	CFCs
Commanding Officer	CO
Committee for Physical Fitness	CPF
Committee on Military Nutrition Research	CMNR
Department of Defense	DoD
Enlisted Evaluations	EVALs
Force Management Policy	FMP
Government Accounting Office	GAO
Health and Physical Readiness	HPR
Institute of Aerobics Research	IAR
Joint Service Working Group	JSWG
Manpower, Reserve Affairs and Logistics	MRA&L
National Health & Nutrition Examination Survey	NHANES
National Institute of Health	NIH
Naval Administrative	NAVADMIN
Naval Health Research Center	NHRC
Naval Medical Research and Development Command	NMRDC
Naval Operations	NAVOPS
Navy Personnel	NAVPERS
Navy Military Personnel Command	NMPC
Navy Personnel Command	NPC
Office of Physical Fitness	OPF
Office of the Chief of Naval Operations	OCNO
Officers Fitness Reports	FITREPs
Physical Fitness Tests	PFTs
Physical Readiness Program	PRP
Physical Readiness Test	PRT
Secretary of Defense	SECDEF
Secretary of the Navy Instruction	SECNAVINST
Standard Error of Estimate	SEE
Standard Error of Measurement	SEM

SUMMARY

This report reviews the development, evolution, and implementation of the Navy's Physical Readiness Program (PRP) through the series of Instructions, numbered 6110.1, on the subject issued by the Office of the Chief of Naval Operations. The first of these Instructions, OPNAVINST 6110.1 (1976) emphasized a program of cardiovascular-respiratory fitness development based on the popular aerobics program of Dr. Ken Cooper.

OPNAVINST 6110.1A (1980) was issued following a presidential request for an assessment of the service's physical fitness. The only change from the previous Instruction was the inclusion of a physical fitness test to allow the assessment of the fitness of Navy personnel.

A comprehensive revision of the program was issued as OPNAVINST 6110.1B (1982). This Instruction was issued to implement new policies promulgated by the Department of Defense (DoD) in its Directive 1308.1 (June 1981). The Instruction contained a new three-level program to develop and maintain health and physical fitness of Navy personnel. The program was named "physical readiness" to distinguish it from previous programs and included consideration of physical fitness, weight control, and health promotion issues. A physical readiness test (PRT) was included, consisting of the time required to run 1.5 miles, or the number of steps-in-place that could be done in 3 min; the number of curl-ups that could be done in 2 min; and measurement of the sit-reach distance. A key aspect of the program was the appointment of Command Fitness Coordinators (CFCs) to be the manager for the Commanding Officers for the implementation of the program.

OPNAVINST 6110.1C (1986) established the basis for policy and practice that has continued to this day. The Instruction was limited to physical readiness (i.e., physical fitness and body fat standards). The health promotion aspects of the previous program were now covered under a separate Instruction. A health risk screen was added to determine suitability for physical readiness testing and/or admission to physical conditioning programs. Body fat content measurement was incorporated into the screening. A new technique for estimation of body fat content and new body fat standards were adopted. The consequences for failing the PRT were spelled out in detail. Guidance was provided for a basic exercise program. Two new items were added to the PRT: number of push-ups performed in 2 min, and the time required to swim 500 yards. The latter was added as an alternative to the 1.5-mile run. Measurement of ability to run in place was dropped as a test item, and the sit-reach distance was made a pass/fail item based on the ability to reach one's toes while seated on the deck.

OPNAVINST 6110.1D (1990) provided a definition of qualifications for the CFC. It offered an improved risk factor screening questionnaire and an improved format for individual records. In the 8 years following the release of this Instruction, several changes to the program were mandated through Naval Administrative messages, and Naval Operations messages. Participation in the PRT by service member's 50 years of age and older was made optional. The body fat standards were changed from a two-tiered set of standards that allowed Navy personnel to attain body fat levels of 26% of body weight for males and 36% for females to a single standard of 22% fat for males and 30% fat for females. The criterion for administrative action for PRT failure was changed such that a service member who had 3 failures in a 4-year period was processed for administrative discharge. These last two changes had a profound effect on the number of Navy personnel administratively discharged for PRT and body fat failures. In addition to these changes, other policy changes included a weight-for-height table as an initial

screening device for body fat content evaluation, and the provision of specific waivers from the application of the body fat standards.

OPNAVINST 6110.1E was released in March 1998, to take effect in September of that year. The purpose of the Instruction was to fine-tune some aspects of the program. CFCs were required to get Instruction to train them for their duties. The weight-for-height screening tables were revised, as was the women's body fat standard, which was increased to 33% fat to provide parity with the men's standard. In addition, minor changes were made to the women's 1.5-mile run standards, new Instructions were issued for the push-ups and curl-ups, changes were made to the sit-reach event, and an exercise requirement for pregnant sailors was issued.

Since the issuance of OPNAVINST 6110.1E, reports have been issued by the Government Accounting Office, and Institute of Medicine that provide recommendations for modification of the service's policies for physical fitness and body fat. A new DoD Instruction is in draft, as is a new OPNAVINST.

An evaluation of the current state of fitness of the Navy suggests that the Navy's PRP is associated with a level of aerobic (health-related) fitness among Navy personnel that is greater than that of their civilian counterparts. This situation is expected to continue.

PREFACE

This report reviews the history of the Office of the Chief of Naval Operations (OCNO) Instructions OPNAVINST series 6110.1, which deals with physical fitness and body fat standards. This review covers weight control/body fat policy, the Physical Readiness Program (PRP), the Physical Readiness Test (PRT), physical conditioning support, and the research that supported the physical readiness policy. When possible, this report discusses the rationale behind, issues surrounding, and implementation of those policies. The report is organized chronologically and traces the progression of physical fitness and body fat policy through the OPNAVINST series 6110.1.

This report was developed, in large part, from my recollection of events. References to supporting documentation are provided whenever possible. I take full responsibility for any misrepresentations, and I apologize for omissions on my part of any important events related to formulation and implementation of physical fitness and body fat policy.

CHRONOLOGY

OPNAVINST 6110.1 (16 June 1976)

It is unclear what events prompted the Chief of Naval Operations (CNO) to take on the responsibility to issue Instructions covering physical fitness.⁸ OPNAVINST 6110.1 was the implementing Instruction for a Secretary of the Navy Instruction (SECNAVINST 6100.2) promulgated in 1962. The OPNAVINST background statement indicates the Navy had published a number of directives addressing the subject of physical fitness over several years preceding this Instruction, but, for a variety of reasons, the implementation of those directives and the maintenance of physical fitness throughout the Navy had not become a reality.

The stated purpose of the Instruction was “To implement a physical fitness program for Navy personnel, regular and reserve, that will meet the need for physical stamina and strength necessary for combat effectiveness and mobilization as directed by [the SECNAVINST].” The subject and sole focus of the Instruction was “physical fitness.” Weight control was covered by a joint Bureau of Personnel and Bureau of Medicine and Surgery Instruction (BUPERSINST 6110.2A/BUMEDINST 6110.1A) that included weight-for-height standards that had to be met. Nonetheless, a definition of obesity was included in the Instruction. Obesity was defined as “excessive accumulation of fat in the body manifested by poor muscle tone, flabbiness and folds, bulk out of proportion to body build, dyspnea (difficult or labored breathing), and fatigue upon mild exertion, all of which detracts from military appearance.” Thus, the Instruction indicated a perceived relationship between body fat content, job performance, and appearance.

In this Instruction, physical fitness was defined as “ability of each individual to carry out his/her daily tasks with vigor and alertness, without undue fatigue, and with ample energy to meet unforeseen emergencies.” Physical fitness in that sense was “necessarily tied to cardiovascular fitness”; however, of equal importance was “the maintenance of sufficient strength to perform an individual’s duties/tasks and sufficient flexibility to avoid injury.” Thus, while emphasizing cardiovascular-respiratory fitness, the Instruction also established strength and flexibility as elements of physical fitness.

The program that was provided was essentially the aerobics program popularized by Dr. Ken Cooper in his book *The New Aerobics*.²⁴ A set of warm-up stretching exercises were provided as well as calisthenics to “improve coordination and posture as well as to increase strength and

endurance.” The rest of the program consisted of Cooper’s aerobic point system with the instruction for each individual “to engage in some aerobic type physical activity that will allow achieving a minimum of 30 points weekly, or 120 points monthly.”

The Instruction did not include a physical fitness test.

Study of Military Services Physical Fitness

On 2 February 1980, the President of the United States requested an assessment of the services’ physical fitness from the Secretary of Defense (SECDEF). This request led to the convening of a symposium on military physical fitness at Arly House in Virginia, 17-19 June 1980. Representatives attended the symposium from each of the services including military and civilian experts from the disciplines of medicine, physical fitness, and physiology. The purpose of the symposium was to review the existing physical fitness policies and practices of the services, and to make recommendations for improving those policies and practices.⁴¹

A Joint Services Study Group was created to review the findings of the Arly House meeting and convey them to the SECDEF for Manpower, Reserve Affairs and Logistics (MRA&L). The findings of the Joint Services Study Group were the following:

- Military services cannot provide an accurate assessment of the physical fitness of their personnel.
- Services do not provide total physical fitness programs to their members of all ages and in all military occupations.
- Skilled professional leadership in physical fitness is lacking in the services.
- Continuing applied research in physical fitness, related to practical problems, is largely nonexistent.
- No dedicated funding or established direction of effort for physical fitness programs or research at the Department of Defense (DoD) or service levels exists.
- A significant gap between the “state-of-the-art” and service physical fitness programs appears to exist.
- Nearly all European countries plus others, including Israel, have well-organized military physical fitness programs. The USSR physical fitness program is highly organized and applies to all military and civilian personnel.
- There is some reason to believe that elite U.S. military units are in acceptable physical fitness status.

The Study Group made the following recommendations:

- That the services establish a system that can determine the current status of physical fitness, recommend objectives, develop programs, and monitor their effectiveness.
- That the SECDEF establish an Office for Physical Fitness (OPF) to provide oversight and guidance of DoD physical fitness policy and programs.
- That the SECDEF support service initiatives in the Planning, Programming, and Budgeting System cycle to improve and expand their physical fitness organizations and programs.

- That the services provide physical training time, as appropriate, to allow the integration of physical fitness activities within the duty day.
- That the SECDEF and the services explore and implement methods for educating service personnel on the value and techniques of applying physical fitness programs.
- That the services assign personnel with educational degrees in physical fitness to positions requiring such expertise. This should include service headquarters and training command headquarters officers responsible for physical fitness policy and programs.
- That SECDEF establishes a DoD Committee for Physical Fitness (CPF) with representatives of the services to include line, training, medical, and physical fitness officers. The committee shall perform a coordinated, continuing review and evaluation of the services' physical fitness programs, research, and tests.
- That a DoD advisory CPF be established with representatives from the civilian medical and physical fitness communities.
- That the OPF and DoD CPF develop and prioritize research requirements in physical fitness and coordinate research projects and studies between the services, as needed.
- That a decision on a DoD Physical Fitness Academy be postponed until a suitable basis is made available to definitely decide against such an organization.
- That the services be encouraged to phase their physical fitness efforts over the near term year to reduce high-surge expenditures and permit time for changes in lifestyles to gradually occur.

OPNAVINST 6110.1A (17 July 1980)

The immediate Navy response to the Arly House meeting was to reissue the physical fitness Instruction. OPNAVINST 6110.1A was virtually identical to its predecessor but included a physical fitness test, apparently to counter the finding that the services could not provide an accurate account of the fitness of their personnel.

Table 1. Physical Fitness Standards From OPNAVINST 6110.1A			
	Age 17–25 years	Age 26–33 years	Age 34–39 years
No. sit-ups in 2 min			
Men:	30	27	25
Women:	22	20	18
Flexed-arm hang time (s) (women only)	16	14	12
No. push-ups (men or women)	20	18	15
No. pull-ups (optional for men)	4	4	3
1.5-mile run/walk time (min:s)	16:30	17:00	17:30
Run in place (optional) (full counts in 3 min)			
Men:	260	240	220
Women:	220	180	160

All Navy personnel under 40 years of age were tested annually. The test consisted of the number of sit-ups that could be performed in 2 min, measurement of flexed-arm hang time for women, and maximum number of push-ups or pull-ups for men, and time to complete a 1.5-mile walk/run or number of run-in-place steps in 3 min. The standards for the test are provided in Table 1.

There was no gender difference in the standards for the 1.5-mile run. Comparison of these standards with those to come in later physical fitness Instructions finds them to be rather lenient. The derivation of these standards is unclear.

DoD Directive 1308.1 (29 June 1981)

Following the issuance of the report on military physical fitness, a new DoD Directive was issued titled “Physical Fitness and Weight Control Programs.”⁴ The basic thrusts of this Directive were as follows:

- Primary emphasis shall be placed on quality programs and secondary emphasis on testing personnel. Military services will conduct remedial training for those who fall below prescribed standards. Continued failure will result in consideration for administrative separation of officers and enlisted members.
- Physical fitness programs and age-adjusted standards shall apply to all personnel.
- Stamina and cardiorespiratory endurance shall receive major emphasis in physical fitness programs.
- Programs shall emphasize 3-4 periods per week of physical training, except in operational environments by waiver of service chiefs.
- Active and reserve physical fitness standards are to be identical.
- The measurement of percent body fat shall be the determining measurement used in weight control policy decisions.
- Medical screening, for selected high-risk personnel, shall be required before placement in a mandatory physical fitness program.
- The Assistant SECDEF (MRA&L) shall coordinate and monitor the DoD physical fitness program within the DoD.
- The services shall develop specific objectives and feedback mechanisms that provide for periodic assessment of their physical fitness and weight control programs.
- Physical fitness shall be included on efficiency or fitness reports. Physical fitness scores will be retained in unit files and most recent test scores will be forwarded to the gaining command upon personnel transfer.

This Directive combined physical fitness and weight control programs (which previously had been covered by separate Directives) and became the driving force for the development of new PRPs in all of the services.

OPNAVINST 6110.1B (19 October 1982)

The Navy’s response to this DoD Directive was the development of OPNAVINST 6110.1B. This Instruction was developed by Navy Military Personnel Command (NMPC) under a newly formed Health and Physical Readiness Program (NMPC-6H) within the Alcohol Rehabilitation

Program office. The Instruction described a three-level program to develop and maintain the health and fitness of Navy personnel. The program was developed with the help of fitness experts, including faculty at local academic institutions, out-of-town experts performing their annual Navy reserve training, and staff of naval medical laboratories.

Program

The program was named “Physical Readiness,” to distinguish it from the previous “Physical Fitness” program, and it included physical fitness, weight control, and health promotion issues. Level I was essentially a “wellness” program described as the promotion of “vigorous and active health and fitness programs at the command level.”¹⁰ Individual commands were to offer programs in weight control, smoking cessation, hypertension control, stress management, substance abuse prevention, and exercise. To manage these programs, OPNAVINST 6110.1B called for the appointment of Command Fitness Coordinators (CFCs) by each Commanding Officer (CO). The CFC was to serve as an advisor to the CO on health and fitness matters. The Commander, NMPC, was responsible for providing information pertaining to the establishment of health and physical fitness programs, and for establishing training for the CFCs.

Level II consisted of an educational program to improve the lifestyle of those not meeting Navy fitness or body fat standards. This program was to be developed for the CFC by NMPC-6H and could involve the use of Counseling and Assistance Centers. Elements of the program were those previously listed: weight control, smoking cessation, hypertension control, stress management, substance abuse prevention, and exercise.

Level III was a residential treatment program, primarily for those who could not meet the body fat standards. The service member had to have been clinically evaluated and medically diagnosed as a compulsive overeater. The service member, in the CO’s opinion, had to have potential for success in continued naval service and had to be recommended by the CO. The 6-week residential treatment was offered at the Alcohol Rehabilitation Centers. Initial versions of Level III used the “Overeaters Anonymous” program as the basis for treatment.

Physical Readiness Test (PRT)

In accordance with the DoD Directive, OPNAVINST 6110.1B included a physical fitness test called the Physical Readiness Test (PRT). This test was to be administered annually and to include stamina and cardiorespiratory endurance items, a strength and muscular endurance item, a flexibility item, and a body composition assessment. Guiding principles for the selection of test items were that they relate to the health and well-being of Navy personnel and that they not require any special equipment that would prevent them from being administered in the field.

Carrying over from the previous Instruction,⁹ stamina and cardiorespiratory endurance were measured as time on a 1.5-mile run, or the number of steps that could be performed in 3 min while running in place. The run-in-place test was to be used in situations where a running course was not available, and it could not be used to qualify for “Excellent” or “Outstanding” categories in stamina.

Strength and muscular endurance were measured by counting the number of sit-ups that could be performed in 2 min. Sit-ups were to be performed with the knee bent and the arms folded across the chest. The individual being tested was to curl-up until the elbows touched the thighs. It was recognized at the time that sit-ups were a measure of muscular endurance but not of strength. Sit-ups were selected as the muscle endurance test item because of some reports linking sit-up training with prevention of lower-back pain. Sit-ups had been a part of the previous Navy physical fitness test, but they were performed with the hands placed behind the

head, and required curling up until the elbows touched the ground. This style, shown to cause injury to the neck and low back, was changed. The flexed-arm hang, push-ups and pull-ups were dropped as test items.

Flexibility was measured for the lower back and hamstrings using the sit-reach test. The individual being tested sat on the deck with his/her legs extended forward with the feet spread 6 inches apart. The individual then reached forward as far as possible touching the floor between his/her legs. The distance reached was measured from a line connecting the heels. Distances less than that to the heels were scored as negative distances. Those greater than that to the heels were scored as positive distances. The test was modified from that used by the American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD).¹ The AAHPERD test required using a box to provide a surface at about seated waist height, across which the person being tested reached. Because the PRT could not require the use of special equipment, the test was modified so that a box would not be needed.

Body composition was also an element of the PRT. Body composition was measured under the following conditions: The member's weight exceeded that on a weight-for-height table provided in the Instruction; the member's CO determined that his/her appearance suggested an excess of body fat; or the member participated in the PRT. The weight-for-height table was taken from OPNAVINST 6110.3, the Navy's previous weight control policy. That Instruction was cancelled by OPNAVINST 6110.1B.

Body fat content, as a percentage of weight, was estimated using the equations of Wright, Dotson, and Davis.^{48,49} These equations had been developed for and were in use by the U.S. Marine Corps as part of its weight control policy.¹⁶ Body fat content was estimated from neck and abdomen circumferences for men, and neck, abdominal, biceps, forearm, and thigh circumferences for women.

Standards

Standards were developed for the PRT based on the consensus of a panel of experts. Performances of elite athletes, standards in previous Instructions, and performances of individuals in adult fitness programs were considered in the development of the standards. When age adjustments were needed, an estimation of 1% decline per year was used. Performances were categorized as "Outstanding," "Excellent," "Good," "Satisfactory," and "Minimum Standard." Separate standards were developed for 6 age groups and for gender within those age groups. The PRT standards under OPNAVINST 6110.1B are provided in Table 2. A Navy service member was required to pass each event (including the body fat) to pass the test.

Inclusion of body composition measures met the requirements of DoD.⁴ It is noteworthy that in this OPNAVINST, the body composition limits did not change with age. NMPC agreed with Navy researchers that there was no research showing that individuals must get fatter as they age, at least not in the age range represented by most Navy service members.

Consequences of failure to meet the standards of the PRT were only vaguely defined. The Instruction states "Continued failure over a reasonable period of time to show progress in meeting minimum Navy standards, when there are no medically limiting circumstances, shall result in consideration for an administrative separation." The decision as to what constituted satisfactory progress was left to the Commander, NMPC. Other Instructions provided sufficient guidance in the instance of separation by reason of obesity (MILPERSMAN 3420440,

SECNAVINST 1920.6), and for requirements to meet weight standards prior to advancement in rate (BUPERSINST 1430.16A).

Table 2. Physical Readiness Classification Table and Test Requirements From OPNAVINST 6110.1B												
AGE	Under 30 years		30 – 34 years		35 – 39 years		40 – 44 years		45 – 49 years		50 years & Older	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
OUTSTANDING												
1.5-MILE RUN	9:45	11:30	10:00	12:00	10:30	12:30	11:00	13:00	11:30	13:30	12:00	14:00
SIT-UPS	100	84	90	75	85	71	80	67	80	67	80	67
SIT-REACH	+2.0	+4.0	+2.0	+3.5	+1.5	+3.0	+1.5	+3.0	+1.0	+2.0	+1.0	+2.0
PERCENT FAT	14	18	14	18	14	18	14	18	14	18	14	18
EXCELLENT												
1.5-MILE RUN	10:45	13:00	11:00	13:30	11:30	14:00	12:00	14:30	12:30	15:00	13:00	15:30
SIT-UPS	75	63	68	56	64	53	60	50	60	50	60	50
SIT-REACH	+1.0	+3.0	0	+2.0	0	+1.5	0	+1.0	-0.5	+1.0	-0.5	+1.0
PERCENT FAT	16	22	16	22	16	22	16	22	16	22	16	22
GOOD												
1.5-MILE RUN	13:00	15:00	14:00	15:30	14:30	16:00	15:00	16:30	15:30	17:00	16:00	17:00
RUN IN PLACE	310	260	280	220	260	200	260	200	240	180	240	180
SIT-UPS	36	30	34	28	32	26	30	25	30	25	30	25
SIT-REACH	0	+2.0	-1.0	0	-1.0	0	-1.0	0	-1.0	0	-1.0	0
PERCENT FAT	18	24	18	24	18	24	18	24	18	24	18	24
SATISFACTORY												
1.5-MILE RUN	14:30	16:30	15:30	17:30	16:00	18:00	16:30	18:30	17:00	19:00	17:30	20:00
RUN IN PLACE	310	260	280	220	260	200	260	200	240	180	240	180
SIT-UPS	36	30	34	28	32	26	30	25	30	25	30	25
SIT-REACH	-1.0	0	-1.5	-0.5	-1.5	-1.0	-1.5	-1.0	-2.0	-1.5	-2.0	-1.5
PERCENT FAT	20	29	20	29	22	29	22	29	22	29	22	29
MINIMUM												
1.5-MILE RUN	15:00	17:00	16:00	18:00	16:30	18:30	17:00	19:00	17:30	19:30	18:00	20:30
RUN IN PLACE	280	235	250	200	230	180	230	180	210	160	210	160
SIT-UPS	33	27	31	25	29	23	27	22	27	22	27	22
SIT-REACH	-1.5	-0.5	-2.0	-1.0	-2.0	-1.5	-2.0	-1.5	-2.5	-2.0	-2.5	-2.0
PERCENT FAT	22	30	22	30	22	30	22	30	22	30	22	30

To meet the DoD requirement to provide for a periodic assessment of the physical fitness and weight control programs, OPNAVINST 6110.1B required NMPC-6H to provide an ongoing evaluation of the Health and Physical Readiness (HPR) program. The Instruction also required the Chief, BUMED, to conduct research in lifestyle areas, including physical fitness and obesity. OPNAVNOTE 6110 (13 August 1984)

In August of 1984, the CNO issued OPNAVNOTE 6110, Ser 153/366201,¹¹ which updated the testing and administrative procedures for conducting the PRT. With issuance of this note, the sit-reach test was now scored as pass/fail. This change reflected reports from the Fleet and review of the scientific literature that suggested that extreme flexion and extension of the lower back posed an injury risk. Since what was desired was a moderate level of flexibility, the sit-reach test was modified. The service member had to sit on the deck and reach forward to touch his/her toes, and hold that position for 1 s. In addition, the run-in-place test was deleted, a 500-

yard swim was added as an alternative to the 1.5-mile run, the maximum body fat allowance was modified for selected age groups, and a test scoring procedure was implemented.

The 500-yard swim was added to provide variety in testing modalities, and to provide an aerobic test for those personnel who had been medically waived from having to perform the run. The swim could be performed using any stroke. No diving starts or kick/flip turns were allowed, and the test could be conducted in open water around floats, if desired. Standards for performance on the swim are shown in Table 3. The derivation of these times is unclear.

Table 3. 500-yard Swim Classification Table.						
Age (years):	Under 30	30 – 34	35 – 39	40 – 44	45 – 49	50 & older
Men						
Outstanding	8:00	8:30	9:00	9:30	10:00	10:30
Excellent	9:45	10:15	10:45	11:15	11:45	12:15
Good	11:30	12:00	12:30	13:00	13:30	14:00
Satisfactory	13:15	13:45	14:15	15:45	16:15	16:45
Minimum	15:00	15:30	16:00	16:30	17:00	17:30
Women						
Outstanding	9:15	10:00	10:40	11:15	12:00	12:45
Excellent	11:40	12:25	13:05	13:50	14:35	15:25
Good	14:15	15:00	15:45	16:30	17:25	18:15
Satisfactory	17:00	17:50	18:40	21:20	22:20	23:15
Minimum	20:00	20:25	21:50	22:45	23:45	24:40

The body fat values shown in Table 2 were changed for some of classifications in the 45-49 and 50 years and older groups. The body fat values to attain a classification of “good” in the 50 years and older group were raised to 19% fat for men and 26% fat for women. The values required to attain a “satisfactory” classification in the 45-49 year group were decreased to 21% fat for men and 27% fat for women. For the 50 years and older group, the value for women was decreased to 28% fat. The “minimum” standards were raised to 23% fat for men and 31% fat for women in the 45-49 year age group and to 24% fat for men and 32% fat for women in the 50 years and older age group.

A test scoring system was implemented in which 5 points were given for each outstanding classification, 4 points for each excellent, 3 points for each good, 2 points for each satisfactory, and 1 point for each minimum classification. Points were assigned for performances on the run or swim, sit-ups, and percent body fat. The points were averaged for the three events and rounded to the nearest integer value.

In addition to the testing and scoring changes, Navy personnel who did not meet the minimum standards on the PRT were required to participate in remedial exercise periods of 30-min duration, three times per week.

OPNAVINST 6110.1C (7 August 1986)

The second revision of the Navy physical readiness policy since the issuance of OPNAVINST 6110.1B was promulgated in 1986 as OPNAVINST 6110.1C.¹² Several major changes were incorporated into this Instruction. The health promotion aspects of the previous HPR program were now covered under a separate health promotion Instruction. OPNAVINST 6110.1C was titled “Physical Readiness.” Naval personnel were required to take the PRT twice

each fiscal year, with no less than 4 months or no more than 8 months between tests. A health risk screen was added to determine suitability for physical readiness testing. Assessment of compliance with body fat standards was removed as an item in the PRT to an independent evaluation, and it served as part of the screening for the PRT. A new technique for estimating body fat and new standards for body composition were adopted. The consequences of failing the PRT were spelled out in detail. Guidance was provided for a basic exercise program. One new items (push-ups in 2 min) was added to the PRT, and new standards were established based in part on distributional statistics derived from samples of Navy personnel. These changes formed the basis for policy and practice that has continued to this day.

PRT Screening

As the first step in PRT screening, the CFC checked to determine whether the member's physical examination was current. If it was not, the member had to get a physical examination before he/she could take the PRT.

The second step was the completion of a risk factor questionnaire. The questionnaire contained questions about cardiovascular disease symptoms, family history of cardiovascular disease, joint problems, age, disease status, smoking, and obesity. The questions are similar to those still in use today.¹⁴ A "yes" answer to any of the screening questions, that is, having disease risk or symptomatology, was cause to refer the service member to the medical department. In that instance, the reviewing medical officer had to approve the member's participation in the PRT as well as in physical conditioning programs.

The third step was the determination of body composition. Body fat content was estimated using equations developed by researchers at the Naval Health Research Center (NHRC).^{28,29} As was the case with the previously utilized Marine Corps equations, these estimations were based on body circumference measurements. For men, height was measured in addition to neck and abdominal circumferences. For women, height was also measured as well as neck, natural waist, and hip circumferences. Circumference and height values were measured and body fat content was determined by looking up height against sums or differences of the circumference values in a table to arrive at a body fat value.

A two-tiered structure for body composition standards was established. Navy service members who exceeded 22% fat for men and 30% for women were judged to be overfat. Those who exceeded 26% fat for men or 36% fat for women were judged to be obese. Members who were found to be obese were referred to the medical department for evaluation. They were not allowed to take the PRT until medically cleared. Service members who were found to be obese upon medical examination were not allowed to take the PRT. If a diagnosis of obesity was sustained for 16 months, the service member was considered for administrative separation.

PRT Changes

OPNAVINST 6110.1C incorporated changes in all areas of physical readiness testing. The sit-reach test was retained as a measure of flexibility.

A new strength and endurance test was added: the number of push-ups that could be performed in 2 min. This test was apparently added because of a NMPC perception that curl-ups were not viewed in the Fleet as a "real" test of strength. Additionally, there was a desire in the Fleet to have a strength test. It was known from the work of Robertson and Trent⁴² that 80% of the physically demanding jobs in the Navy involved pushing, pulling, lifting, or carrying. Push-ups were perceived as a dynamic strength test, and seemed to satisfy the Fleet's desire for such a test. The selection of push-ups as a "strength" test added weight to the misperception that they,

in fact, measure strength. Because push-ups are a repeated submaximal exercise, they, like curl-ups, are a measure of muscle endurance.

The number of curl-ups that could be performed in 2 min was retained as a measure of muscle endurance. Performance of curl-ups continued to be viewed as valuable in decreasing the risk of low-back injury.

Requirements for the 500-yard swim were modified. The test had to be carried out in a 25- or 50-yard pool. Only the crawl stroke could be used. Goggles or a mask could be worn, but not fins, snorkels, or other flotation or propulsion devices. A diving start still could not be used, nor could "flip" or somersault turns.

Body Composition Standards and Measurement

Standards. The body composition standards were based on health considerations. Four sources were considered in determining these health-related standards: (a) results from the National Health and Nutrition Examination Survey (NHANES) I, (b) results from NHANES II, (c) recommendations from a current monograph of the time,⁶ and (d) results from the Consensus Conference of the National Institutes of Health (NIH).³⁷

The NHANESs provide some of the most comprehensive data on prevalence of cardiovascular disease risk factors and obesity in the United States.³⁵ NHANES I data were collected from 1971 to 1974. NHANES II was conducted from 1976 to 1980. In both these surveys, the basis for allocation into higher- and lower-risk groups was based on whether the individual lay above or below the 85th percentile for the sum of triceps and subscapular skinfold (NHANES I) or for body mass index (BMI) (equal to weight [kg] divided by height [m] squared) (NHANES II).

Behnke and Wilmore developed the so-called reference man and reference woman wherein standard body proportions were developed based on median values for a variety of anthropometric measurements.⁶ By analyzing changes in body proportions with increasing levels of fatness, they determined that the point at which adipocytes were "full" and any further increase in fatness was due to laying down more adipose tissue was at percent fat values of 21.5 for males and 36.4 for females (when including the "essential" fat in the percentage).

In February 1985, NIH held a consensus development conference dealing with the health implications of obesity.³⁹ From that conference, a consensus statement was developed that defined obesity as "an excess of body fat frequently resulting in a significant impairment of health." The panel agreed that an increase in body weight of 20% or more above desirable body weight constituted an established health hazard. Therefore, weight reduction was recommended for persons "with excess weight of 20% or more above desirable weights in the Metropolitan Life Insurance Company tables," or the BMI equivalent of 27.2 for men and 26.9 for women (based on the more-liberal 1983 tables).³⁸ In setting these standards, the consensus panel recognized that measures of height and weight "only approximate the precise magnitude of fatness," but were the only measures that a great deal of epidemiological data were available.

Because the DoD policy was that percent fat values be used as the basis for weight reduction, it was necessary to determine relationships between the potential standards provided from each of the preceding sources and percent body fat. To do this, the NHRC body composition data set was used. At that time, the data set contained the measurements of 997 male and 337 female Navy personnel. Regression equations to predict percent body fat for males and for females from (a) the sum of triceps and subscapular skinfold thicknesses (for conversion of NHANES I findings), (b) BMI (for conversion of NHANES II findings), and (c) weight and height as

separate factors (for conversion of the NIH weight-for-height consensus definition). The results of analysis of the NHANES studies and the NIH consensus definition are shown in Table 4.

Table 4. Estimation of Body Fat Limits		
Study	Criteria	Percent Fat Equivalent
NHANES I	85 th percentile, sum of triceps and subscapular skinfold thickness	Males: 38 mm = 25.7% fat Females: 52 mm = 34.7% fat
NHANES II	85 th percentile, BMI	Males: 27.8 kg/m ² = 23.0% fat Females: 27.3 kg/m ² = 34.2% fat
NIH consensus conference	120% of the desirable weight for medium-framed individual on MetLife Tables (1983) or BMI	Males: avg. ^A = 22.2% fat 27.2 kg/m ² = 22.2% fat Females: avg. ^A = 33.6% fat 26.9 kg/m ² = 33.6% fat
^A Average is of the percent fat values calculated for each height in the Metropolitan table		

Analysis of the limits from these sources suggested that a suitable limit for percent body fat lay between 21% and 26% fat for males and 33% and 37% fat for females. The NIH consensus definition of obesity was chosen as the basis of the standards for three reasons: (a) because it was based on the Metropolitan Life Insurance tables that reflect an empirically derived health-related outcome death; (b) because it represented the consensus of a large group of experts, including investigators from the NHANES studies that we also considered; and (c) because it carried the sanction of the nation's premier scientific institutes. It was felt these points made the standards more defensible than if they had been based on one of the cross-sectional studies.

NMPC accepted standards of 22% fat for men and 33% fat for women based on the analysis of the NIH consensus definition. However, all estimations of body composition have error associated with them. The standard errors of measurement (SEM) associated with prediction of percent fat from Navy equations were 3.5% fat for men and 3.7% fat for women.^{28,29} Because of the uncertainties associated with estimations based on regression equations, a two-tiered system of policy enforcement was created. Twenty-two percent and 33% were accepted as Navy goals (so-called "overfat" levels). To decrease the chances of inappropriate administrative action (*i.e.*, false positives: those whose body fat estimation from circumferences exceeded the standards, but who would not have exceeded the standard via underwater weighing), a buffer zone of 3% body fat (approximately 1 SEM) was adopted. Navy personnel exceeding the Navy goals of 22% fat for men and 33% fat for women were to be put on mandatory physical training. Sailors would not be subject to punitive action until they exceeded the second, higher limit called the "obesity" level (26% fat for men, 36% fat for women).

At the time of inclusion of these standards into the Instruction, the women's goal was lowered to 30% fat. The rationale for this change is unknown. Perhaps it was to reflect the definitions of the original panel on physical fitness in the service, or perhaps it was because 30% fat had been the maximum value allowed under the previous Instruction.

Measurement. As previously mentioned, NHRC was tasked by the Naval Medical Research and Development Command (NMRDC) to develop new equations to estimate body fat content in Navy personnel. They developed separate equations for men and women based on samples of

602 men and 214 women. It was decided to predict body density (from which body fat content could be calculated) rather than body fat content in order that any refinements in the estimation of body fat content from body density could be incorporated directly, without any further research.

The equations developed to predict body density were:

$$\text{Body Density} = -0.191 \times \text{Log}_{10}(\text{abdomen circ.} - \text{neck circ.}) + 0.155 \times \text{Log}_{10}(\text{height}) + 1.032$$

for men, where all measurements were in centimeters and

$$\text{Body Density} = -0.350 \times \text{Log}_{10}(\text{waist circ.} + \text{hip circ.} - \text{neck circ.}) + 0.221 \times \text{Log}_{10}(\text{height}) + 1.296$$

for women, again, with all measurements in centimeters

Percent body fat was computed using the equation of Siri.⁴⁴

$$\text{Percent Body Fat} = 100 \times \left(\frac{4.95}{\text{Body Density}} + 4.5 \right)$$

The correlation coefficients between percent fat predicted by these equations and that determined from two-compartment analysis of underwater weighing data were 0.90 (standard error of estimate [SEE] = 3.5% fat) for men, and 0.85 (SEE = 3.7% fat) for women. These correlations and SEE were as good or better than those associated with other commonly used skinfold and/or circumference-based equations.^{28,29}

Additional research was carried out investigating the use of whole body bioelectric impedance to predict body fat content in Navy personnel. These studies showed that the circumference-based equations were superior to those involving height, weight, and whole body resistance at 50 kHz.^{31,32,37,43}

Based on this research, NMPC adopted the equations developed at NHRC as the basis for determining body fat content for Navy personnel.

PRT Standards and Point System

New PRT standards were promulgated with OPNAVINST 6110.1C, and the categories for PRT classification were changed. The “Minimum” category was dropped. The age groups were reorganized so that they now represented decades. All Navy personnel 50 years of age and older were included in the same age group. These standards were developed based on research NHRC conducted for NMPC-6H.

To meet the research requirements called for in OPNAVINST 6110.1B, NMPC tasked NHRC in 1983 to develop and execute a program of research to evaluate the HPR program.^{15,18} The research included two parts: the collection of cross-sectional baseline samples of shore-based and shipboard personnel, and the establishment of a cohort of Navy personnel that could be studied longitudinally. The baseline samples consisted of 6,182 shore-based personnel (4,923 men, 1259 women),⁴⁰ and 3,979 shipboard personnel.²² Male standards for the run and sit-ups were developed based on distributional statistics of these two Navy personnel samples.

The population distributions were analyzed by age group. NHRC suggested category cut-off of the 95th percentile for “Outstanding” (revised upward from the 90th percentile, following NMPC review), the 80th percentile for “Excellent,” the 50th percentile for “Good,” the 20th percentile for “Satisfactory,” and the 5th percentile for “Minimum,”²⁰ with a 2-year phaseout of the “Minimum” category. Standards were provided for the sit-reach (pass/fail), sit-ups in 2 min,

push-ups in 2 min, maximum number of pull-ups (for men only) and the 1.5-mile run for age groups 17–19 years, 20–29 years, 30–39 years, and 40 years and older.

Standards for women were developed using the U.S. Army physical fitness standards that were in effect in 1985. The Army Physical Fitness Test (PFT) included the number of push-ups and the number of sit-ups that could be performed in 2 min as test items for both men and women. Relationship between male and female standards on the sit-up test were determined and applied to the Navy male standards developed from the Navy samples. The Navy data did not include measurement of the number of push-ups that could be performed in 2 min. To establish standards for Navy personnel, a regression to predict push-up performance from sit-up performance was developed using the Army standards. This model was then applied to Navy sit-up standards to determine the push-up standards.

In addition, NHRC provided a set of point scales to provide an overall measure of PRT performance, much like that in use by the U.S. Marine Corps. Separate point scales were developed for each age and gender group. The maximum number of points that could be achieved was 100 for each event, except for the sit-reach, which was a pass/fail event. The maximum for the PRT was 300 points.

After review of the NHRC suggested standards, NMPC-6H decided not to use pull-ups as a PRT item. NMPC also decided to add an age group. The 40 years and older group were divided into two groups, 40–49 years and 50 years and older. In addition, NMPC provided a table of 500-yard swim times for inclusion in the Instructions.

NHRC was asked to develop standards for the 50 years and older group for all PRT items, and to drop the “Minimum” level of classification. The 40 years and older standards were retained as the 40–49 years age group standards. There were sufficient numbers of 50 years and older men in the baseline samples to develop sit-up and 1.5-mile run time standards for that age group. Women’s standards and push-up standards were developed in the same fashion that they had been for the first iteration of suggested standards.

In addition, NHRC developed a single table of point values for overall PRT classifications for each age and gender group. The points were derived from the percentile values for performances using the complete baseline sample for each of the items. While the exact details have not been discovered, the process was one wherein PRT item performance values at two percentiles (e.g., the 90th and 10th, were assigned point values of 90 and 10, respectively, and used to determine the linear relationship between points and performance for that PRT item). This linear relationship was then used to generate performance values for each point on the scale. Possible points for each PRT event ranged from zero to 100, with 100 representing the best performance in relation to lesser point values. Point values for each classification level were set as the sum of the points associated with that classification level on each individual PRT. That is, the total points for “Outstanding” for a given gender and age group was the sum of the points associated with “Outstanding” performance on each of the PRT items (sit-ups, push-ups, and 1.5-mile run or 500-yard swim) for that group. Point values for the PRT, then, ranged from zero to 300. The use of a single point scale for each event with different classification values for each age and gender group was adopted by NMPC because it seemed simpler to present and use than different point scales for each gender/age group. Failure of any event in the PRT constituted failure of the PRT. In such a case, points were not assigned.

The revised standards for the PRT items and the point system were given to NMPC-6H, accepted, and included in OPNAVINST 6110.1C.²³ The PRT standards are provided in Table 5.

Table 5. Physical Readiness Classification Table and Test Requirements From OPNAVINST 6110.1C											
AGE	17 – 19 years		20 – 29 years		30 – 39 years		40 – 49 years		50 years & Older		
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	
SIT-REACH											
Pass/Fail	Touch Toes		Touch Toes		Touch Toes		Touch Toes		Touch Toes		
SIT-UPS IN 2 MIN											
Outstanding	88	86	84	84	75	74	73	72	68	67	
Excellent	72	67	68	61	54	54	48	48	45	45	
Good	60	52	50	45	40	39	35	34	33	32	
Satisfactory	45	40	40	33	32	27	29	24	27	22	
PUSHUPS IN 2 MIN											
Outstanding	62	36	52	29	45	23	41	22	38	21	
Excellent	57	31	48	24	41	19	37	18	35	17	
Good	51	24	42	17	36	11	32	11	30	10	
Satisfactory	38	18	29	11	23	5	20	5	19	5	
1.5-MILE RUN/WALK TIME (min:s)											
Outstanding	9:00	11:30	9:15	11:30	10:00	12:00	10:15	12:15	10:45	12:45	
Excellent	9:45	13:30	10:30	13:15	11:45	13:45	12:15	14:15	12:30	14:45	
Good	11:00	15:00	12:00	15:00	13:45	15:30	14:30	16:15	15:15	16:45	
Satisfactory	12:45	16:15	13:45	16:45	15:30	17:15	16:30	18:15	17:00	19:00	
500-YARD SWIM TIME (min:s)											
Outstanding	8:00	9:15	8:00	9:15	10:15	12:15	11:15	13:15	11:45	13:45	
Excellent	9:45	11:45	9:45	11:45	11:45	13:45	12:15	14:45	12:45	15:15	
Good	11:30	14:15	11:30	14:15	14:15	15:45	15:15	16:45	15:45	17:30	
Satisfactory	13:15	17:00	13:15	17:00	15:45	17:15	16:45	18:30	17:30	19:15	

Basic Exercise Program

The Instruction provided a basic exercise program to allow service members to prepare themselves for the PRT. The program included guidelines for warm-up calisthenics, flexibility exercises, muscle endurance exercises, and aerobic conditioning exercise. The guidelines for muscle endurance exercise and aerobic conditioning focused on the events contained in the PRT, but they provided an approach to training that could be used for any exercise.

Consequences of Failure

OPNAVINST 6110.1C spelled out the consequences of failure to meet PRT and/or body fat standards. A variety of consequences were associated with being overfat or obese, as well as with failure on the PRT (see Table 6). Officers or enlisted personnel who failed any component of the PRT, and personnel who fell into the overfat or obese categories on the body fat evaluation were required to participate in the command-directed Level I program. Action for separation was not considered unless a service member had failed the PRT for the third consecutive time or had been found to be obese for the third consecutive PRT cycle.

Reporting Results

The OPNAVINST required reporting of the most recent PRT results on Officer Fitness Reports (FITREPs) and Enlisted Evaluations (EVALs). This reporting included separate notations for the PRT and the body fat evaluation. Specific language was provided for recording the PRT results in the FITREPs and EVALs.

Table 6. Administrative and Statutory Action for Members Failing the PRT or Exceeding Body Fat Standards

	Fail PRT		Overfat		Obese	
	1 st /2 nd Test Cycle	3 rd + Test Cycle	1 st /2 nd Test Cycle	3 rd + Test Cycle	1 st /2 nd Test Cycle	3 rd + Test Cycle
Recommended for promotion/ advancement	Yes	No	Yes	No	No	No
Delay promotion/withhold advancement	No	Yes	No	Yes	Yes	Yes
Eligible for frocking	No	No	No	No	No	No
FITREP entry	Yes ¹	Yes	No	Yes	Yes	Yes
EVAL entry	Yes	Yes	No	Yes	Yes	Yes
Eligible for Reenlistment	Yes	No	Yes	Yes	No ²	No
Possible separation	No	Yes	No	No	Yes	Yes

¹ The narrative entry will reflect the most recent test results

² May be extended until they have had 16 months in a remedial program.

DoD Instruction 1308.1 (29 June 1981) required the services to provide periodic assessment of their physical fitness programs. To meet this requirement, a command PRT summary report was created, symbol OPNAV 6110-3. It was to be used to record and collect data on each PRT. Each year, before 30 September, each command was to submit the most recent OPNAV 6110-3 through its chain of command to NMPC-6H.

Inspection Item

Health and physical readiness was established as a command inspection item. An inspection guide was included in OPNAVINST 6110.1C listing aspects of program implementation to be rated.

Research and Development

In support of the PRP, several research efforts were carried out. As previously mentioned, NMPC provided funding for the collection of a baseline sample of PRT performances by Navy personnel, as well as a longitudinal study of a cohort of Navy personnel, stratified by age, officer/enlisted status, and ship or shore commands, to allow measurement of trends in physical fitness and wellness with the implementation of the PRP. The baseline sample data were used to generate the standards promulgated in 6110.1C.

In addition, several other studies were conducted with a combination of NMPC and BUMED funding. A study was conducted to investigate the relationship between 1.5-mile run time and 500-yard swim time, and to develop a cycle ergometer test as an alternative to the 1.5-mile run. Another study measured the PRT performances of Navy recruits at the beginning and at the end of recruit training. Another attempted to link PRT performance to performance of Navy job tasks.

Alternative Tests

500-yard swim test. As previously noted, OPNAVNOTE 6110 of August 1984 and OPNAVINST 6110.1C provided for a 500-yard swim test that could be taken instead of the 1.5-mile run. The NMPC provided the table of values. I have not been able to determine the procedures, sources, or rationale used to determine these 500-yard swim time standards. It is my recollection that NHRC was told that these times were derived from data from the Cooper Clinic, but I have been unable to reproduce the tables in OPNAVINST 6110.1C from the published Cooper Clinic data.²⁵

The swim times were strongly related to run time. Regressions for each gender and age group are provided in Table 7. An analysis of variance of the relationship between run time and swim time revealed a significant three-way interaction (run time by age group by gender; $F_{3,19} = 3.81$, $p = 0.027$). Post hoc regression analysis indicated gender differences in the relationships between run time and swim time only for the two youngest age groups: 17–19 years ($t = 5.16$, $p = 0.004$) and 20–29 years ($t = 3.67$, $p = 0.014$). The regressions for the three oldest age groups, 30–39 years, 40–49 years, and 50 years and older, did differ significantly ($p > 0.05$ for gender and age group effects, and all interactions). The common regression for the age and gender groups including service members 30 years of age and older was:

$$\text{Swim Time} = 0.962 \times \text{Run Time} + 0.960$$

where Swim Time is the time to complete a 500-yard swim and Run Time is the time to complete a 1.5-mile run.

The correlation coefficient for this relationship was 0.99 and the SEE was 0.34 min. The standard error value was reasonable considering all times were rounded to the nearest 0.25 min. Given the strength of the relationship between run time and swim time, it was suggested that the swim times were based on some translation of the run time standards.

Table 7. Relationships Between 1.5-Mile Run and 500-Yard Swim Times				
Age Group/Gender	Slope	Intercept	Correlation Coefficient	SEM (min)
17-19 years/male	1.357	-3.789	0.984	0.397
20–29 years/male	1.160	-2.573	0.997	0.168
30–39 years/male	1.029	-0.122	0.997	0.192
40–49 years/male	0.932	1.409	0.987	0.418
≥50 years/male	0.918	1.572	0.990	0.361
17-19 years/female	1.613	-9.616	0.992	0.424
20–29 years/female	1.471	-7.721	1.000	0.079
30–39 years/female	0.971	0.543	0.998	0.129
40–49 years/female	0.888	2.278	0.999	0.121
≥50 years/female	0.903	2.162	0.997	0.191

In 1986/87, a study was conducted at San Diego State University by the Department of Physical Education. The aims of the study were twofold: (a) to explore the relationships

between performance on the 1.5-mile run and the 500-yard swim to provide a basis for development of rational standards for the swim; and (b) to develop a bicycle ergometer-based test of aerobic capacity to use as a low-impact alternative to the 1.5-mile run. The results of these studies have been reported by Buono.⁷

In the swim portion of the study, 60 participants (32 women and 28 men, mean age approximately 25 years) had their maximal rate of oxygen consumption ($\text{VO}_{2\text{max}}$) determined from open-circuit spirometry during a graded exercise test on a motor-driven treadmill. They also had their swimming skill determined, swam 500 yards for time, and ran 1.5 miles for time. Swimming skill was assessed by observation using a structured scoring system developed at San Diego State University. Swimming skill was rated on a 1.0 to 3.0 scale in 0.25 point increments. Based on this point scale, swimmers were rated as beginner, intermediate, or advanced. Physical characteristics of the subjects are provided in Table 8, and correlations among the measures are shown in Table 9.

Table 8. Swim Study Participant Characteristics¹			
Measure	Men (<i>N</i> = 28)	Women (<i>N</i> = 32)	Total sample (<i>N</i> = 60)
Age	25.9 ± 4.4	23.7 ± 4.6	24.8 ± 4.6
Height (cm)	178.3 ± 7.7	168.7 ± 6.1	173.2 ± 8.4 ²
Weight (kg)	74.5 ± 9.0	60.7 ± 6.6	67.4 ± 10.4 ²
Percent fat	10.6 ± 4.9	19.6 ± 6.1	15.2 ± 7.1 ²
$\text{VO}_{2\text{max}}$ (ml·kg ⁻¹ ·min ⁻¹)	58.8 ± 9.1	46.5 ± 8.0	52.4 ± 10.5 ²
1.5-mile run time (min)	9.77 ± 1.70	12.06 ± 2.64	10.95 ± 2.50 ²
500-yard swim time (min)	9.38 ± 2.93	9.69 ± 2.86	9.54 ± 2.88
Swim skill	2.27 ± 0.67	2.12 ± 0.74	2.20 ± 0.70

¹ Values shown are means ± SD

² Values differ between men and women

Table 9. Selected Correlations				
	% fat	$\text{VO}_{2\text{max}}$	1.5-mile run	500-yard swim
$\text{VO}_{2\text{max}}$	-0.73**			
1.5-mile run	0.76**	-0.84**		
500-yard swim	0.22	-0.33*	0.42*	
Swim skill	-0.32*	0.31*	-0.43*	-0.85**

*Correlation is significant at the $p < 0.05$ level (two-tailed)

**Correlation is significant at the $p < 0.001$ level (two-tailed)

The values shown in Table 8 show the study participants to be young, healthy, active adults. It can be seen in Table 9 that the highest correlations are between 1.5-mile run time and $\text{VO}_{2\text{max}}$ and between 500-yard swim time and swimming skill. Percent fat is also strongly related to $\text{VO}_{2\text{max}}$ and 1.5-mile run time. The 500-yard swim time, while significantly correlated, is not strongly related to $\text{VO}_{2\text{max}}$ (10.6% of the variance explained) or to 1.5-mile run time (17.7% of the variance explained). In multiple regression analysis, to predict swim time from swim skill,

1.5-mile run time, and percent fat, swim skill was entered first and was the only significant predictor. Once swimming skill was known, there was no variance to be predicted by 1.5-mile run or VO_{2max} . These findings suggested that the swim test is an inadequate substitute for the 1.5-mile run, at least as a predictor of aerobic fitness.

Despite the relatively weak relationship between the swim and run, the best regression to predict swim time from the 1.5-mile run time was calculated and a table of swim standards was generated.⁷ The regression predicting swim time from run time was:

$$\text{Swim Time} = 0.484 \times \text{Run Time} + 4.244$$

where all times are in minutes. The multiple correlation coefficient for this equation was 0.42 and the SEE was 2.63 min. The 500-yard swim times predicted by this equation from the 1.5-mile run time standards are provided in Table 10.

In general, the range of swim times is less than that found in OPNAVINST 6110.1C, and the changes with age are fewer. For the 50 years and older group, the “Satisfactory” category limit shown in Table 10 would be “Excellent” for males and “Outstanding” for females. It should be remembered that the regression developed to predict the values shown in Table 10 was developed on a sample of swimmers whose mean swimming skill level was 2.1 (intermediate) on a scale of 1.0 (beginner) to 3.0 (advanced). Advanced swimmers would be expected to require less time than the values shown in Table 10. Given the differences between the standards in OPNAVINST 6110.1C and those provided here, Navy service members would be expected to perform very well on the swim, particularly in the older age groups. Service members with perhaps only moderate aerobic capacity, but good swim skills, would be able to substantially enhance their performance on the PRT by choosing the 500-yard swim.

Table 10. 500-Yard Swim Times Predicted From 1.5-Mile Run Time Standards										
	17-19 years		20-29 years		30-39 years		40-49 years		50 years & older	
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>
Outstanding	8:46	9:58	8:53	9:58	9:15	10:13	9:22	10:20	9:37	10:34
Excellent	9:08	10:56	9:29	10:49	10:05	11:03	10:20	11:17	10:27	11:32
Good	9:44	11:39	10:13	11:39	11:03	11:53	11:25	12:15	11:46	12:29
Satisfactory	10:34	12:15	11:03	12:29	11:53	12:44	12:22	13:13	12:37	13:34

5-km stationary cycle “ride.” The second study carried out under the San Diego State University contract was the development of a stationary cycle performance test.⁷ Such a test, while requiring maximal performance, would eliminate the pounding to the joints associated with running. It was a test, therefore, that could be used by individuals with joint problems, who might not be able to run. The test was designed to be like the run as much as possible. The test was based on the time required to “travel” a set distance as indicated on the cycle odometer. The distance, 5 km, was chosen because the time required to finish the test would be similar to that required to finish the run. The test was also like the run in that the energy required was a function of body weight. In this case, the resistance on the cycle ergometer was set to 0.5 kg for every 20 kg of body weight.

A sample of 9 male and 11 female college students had their VO_{2max} determined from open-circuit spirometry measurements obtained during a graded exercise test on a motor-driven treadmill. In addition, they ran 1.5 miles for time and pedaled the equivalent of 5 km on a

stationary cycle ergometer with a resistance of 0.5 kg for each 20 kg of body weight. Performance on the cycle test was strongly related to $\text{VO}_{2\text{max}}$ ($R = -0.78$), and to 1.5-mile run time ($R = 0.94$). The investigator concluded that the cycle ergometer test was suitable for use by the Navy, but that it needed to be validated on a sample of Navy personnel. A regression equation was developed to predict 5-km cycle times from 1.5-mile run times. The best linear equation was:

$$\text{Cycle Time} = 0.76 \times \text{Run time} + 37.6$$

where all times are in seconds. The correlation coefficient for this relationship was 0.94 with a SEE of 54.8 s. Suggested performance standards for the 5-km cycle test are presented in Table 11.

	17-19 years		20-29 years		30-39 years		40-49 years		50 years & older	
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>
Outstanding	7:28	9:22	7:40	9:22	8:14	9:45	8:25	9:56	8:48	10:19
Excellent	8:02	10:53	8:37	10:42	9:34	11:05	9:56	11:28	10:08	11:50
Good	8:59	12:01	9:45	12:01	11:05	12:25	11:39	12:59	12:13	13:22
Satisfactory	10:19	12:59	11:05	13:22	12:25	13:44	13:10	14:30	13:33	15:04

Recruit Training and PRT Performance

In 1984, a study was carried out to examine the fitness of individuals entering and leaving Navy recruit training.³⁰ Physical fitness measures were taken on 302 male and 393 female recruits upon entry into and at the completion of recruit training. In addition to the PRT measurements, triceps skinfold thickness was measured as well as maximum number of pull-ups for the male recruits and flexed-arm hang time for the female recruits. In general, the study concluded that it was difficult to find normative civilian data against which to compare the incoming recruits. However, recruits entering training were less fit than Fleet sailors of the time, but at the end of recruit training, they had surpassed their fleet counterparts in PRT performance. This information was used by the CNO as part of the justification of work with the President's Council on Physical Fitness and Sports on youth fitness.¹⁹

Job-Related Physical Readiness Standards

An investigation was undertaken in late 1986 to determine whether emergency shipboard tasks could be used as the basis for setting physical readiness standards for sea duty. NHRC investigators took part in basic firefighting and damage control training, and they interviewed subject matter experts about the perceived demands of firefighting and damage control operations. The conclusions from these investigations were that the demands associated with shipboard firefighting performed by most sailors were minimal due to the team nature of the task (shared workload) and the rotation among positions on the team while fighting fires. The demands placed on trained firefighting crews are greater and include heat tolerance. With respect to damage control, it again was concluded that the physical demands expected of most sailors were minimal and that all trainees, regardless of age or sex, accomplished damage control training exercises. Because of these findings, the exploration of firefighting or damage control tasks as a basis for general shipboard fitness requirements was abandoned.

OPNAVINST 6110.1D (18 January 1990)

A new CNO Instruction was issued in January 1990.¹³ The Instruction was issued in response to needs to define CFC qualifications, improve the risk factor screening, and improve individual recordkeeping.

CFC Qualifications

To ensure the CFCs were appropriate role-models in their jobs as fitness and health advisors, the Instruction required that CFCs:

- are E-5 or above
- are CPR certified
- meet satisfactory PRT standards
- are not overfat or obese
- are not tobacco users
- are encouraged to obtain American College of Sports and Medicine (ACSM) certification

This last requirement was presented as a method of providing training for CFCs. Previously, NMPC had offered training courses for CFCs, directly or through contract efforts. Negotiations with the ACSM to provide a certification for military exercise leaders were opened, but they fell through. Following the collapse of this effort, CFCs were encouraged to pursue the standard ACSM Exercise Leader Certification, and a Command Fitness Coordinator Reference and Training Manual (S/N 0500-LP-175-4200) was provided that contained the appropriate didactic material to support the Exercise Leader Certification test.

Revised PRT Screening

The PRT screening was modified. A new form (OPNAV 6110.2) was created in the form of a manila folder. The new form provided the opportunity to record results from 6 consecutive PRT screenings and/or administrations. The questions in the Risk Factor Questionnaire portion of the form were modified to ask whether there had been “significant change in” the risk factor since the last periodic physical or PRT. In the previous Risk Factor Questionnaire, service members were asked about the presence or absence of risk factors. Each “yes” answer required a referral to the medical department, despite the same risk factor having been evaluated and resolved during the previous PRT review. The assessment of change in status was enacted in an attempt to minimize unnecessary referrals to the medical department. In addition, the medical referral section of the form was expanded to include more than an obesity determination, and it offered the option to waive specific items on the PRT as a result of existing medical conditions. Included in the Instruction was increased guidance concerning the criteria for a diagnosis of obesity and assessment of cardiovascular risk.

PRT Standards

The PRT items, standards, and point values were unchanged from OPNAVINST 6110.1C. The basic conditioning program was also unchanged. The conditions necessary for and procedures to be followed for PRT administration were spelled out in greater detail than in the previous Instruction. Instructions for the 500-yard swim incorporated the change, previously enacted in a NAVADMIN, in which any stroke and style of turn was to be allowed during the swim.

Changes to PRP

In the 8 years following the release of OPNAVINST 6110.1D, several changes were made to the PRP. These changes were promulgated through the use of NAVADMINs and NAVOPs.

On January 24, 1990, just 6 days after the release of OPNAVINST 6110.1D, NAVOP 009/90 was released. The purpose of NAVOP 009/90 was to standardize the reporting of physical readiness information on FITREPs and EVALs, by including percent body fat and status on fitness testing into block 73.

In June 1990, 6 months after the promulgation of OPNAVINST 6110.1D, participation in the PRT by Navy service personnel 50 years of age and older was made optional by NAVOP 064/90. These older service members were required to meet the body fat standards, and encouraged to “demonstrate leadership by example and live healthy and active lifestyles.”

This change was enacted out of concern following the occurrence of several sudden death incidents associated with the PRT.

Two changes in the PRP that would have a profound effect on the number of Navy personnel, who would be at risk for administrative action under the program, were enacted in April 1993 through NAVADMIN 071/93. Under this NAVADMIN, the two-tiered structure for the body composition standards was removed. In place of the two-tiered structure based on the overfat and obesity ratings, a single standard of 22% fat for men and 30% fat for women was implemented. Those Navy personnel in the overfat category were now out of compliance with

Navy Enlisted Body Fat/Fitness Separations

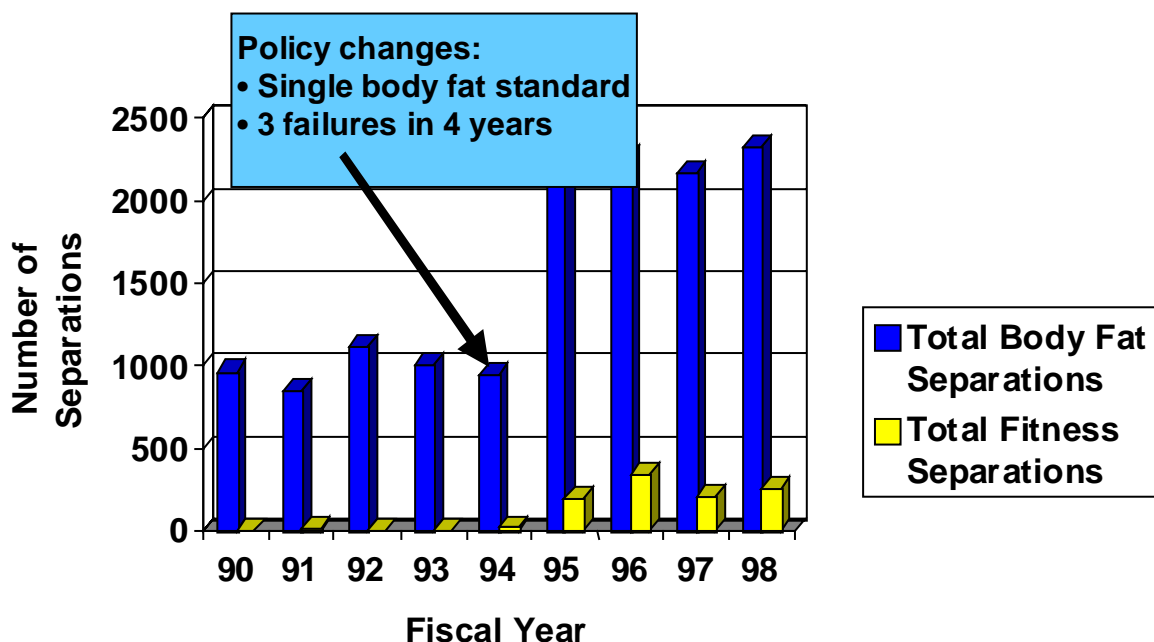


Figure 1. Changes in administrative separations associated with PRT policy changes. Figure adapted from Naval Personnel Command (NPC-601).

standards. In addition, this NAVADMIN redefined the criterion for administrative action with respect to PRT failures. A service member who failed the PRT 3 times in a 4-year period was processed for administrative separation. Specific administrative actions related to PRT failures were also redefined. Figure 1 shows the changes in PRT failure rates associated with the release of this NAVADMIN. It is evident that the number of administrative separations due to exceeding the body fat standards more than doubled from 1993 to 1995. The number of separations due to exceeding body fat standards increased from an average of 982 personnel per year during the period 1990 to 1993 to an average of 2,240 personnel per year for the period 1995 to 1998. The number of separations due to PRT failures increased from 2.5 personnel per year for 1990 to 1993 to 249 per year for 1995 to 1998. The minimum time required to fail the PRT 3 times is 1.5 years. Therefore, the impact of the policy change would be expected to appear no earlier than 1995, and the pattern seen in Figure 1 is consistent with the expected timing of changes resulting from the NAVADMIN.

Other NAVADMINs released in 1993 provided increased definition of the safety requirements for PRT administration. NAVADMIN 189/93 required that the physical exam be current, the risk factor screening completed 10 to 12 weeks prior to PRT administration, emergency medical care be available at the test site, 2 persons trained in CPR be on-site, and it provided guidance for reporting injury or death associated with the PRT. NAVADMIN 190/93 provided refinement of the administrative consequences of PRT failures. It is not thought that these changes had much impact on the pattern of PRT failure rates.

In 1994, other major program changes were enacted. NAVADMIN 148/94 called for COs to make physical training a part of the weekly routine for all members. Participation in an aerobic exercise program was required at least 3 times each week, with exercise sessions to last at least 30-40 min. Service members were excused from physical training for validated medical reasons, or if their military duties made exercise impossible. Individuals on limited duty were required to participate in physical exercise to the extent allowed by their physician. Commands were encouraged to use Moral Welfare and Recreation facilities to implement their physical exercise programs.

This change in PRT policy was the result, in part, of a joint meeting of the BUMED, BUPERS, and Navy Safety Center personnel held in 1993. There was concern over the number of reported injuries and deaths associated with the PRT. Reviews of the literature reported at this meeting indicated that the risk of negative cardiovascular events was decreased overall for those who exercised regularly. It was the consensus of those attending this meeting that the best way to minimize injuries and deaths during the PRT was to ensure that service members were physically active. BUPERS adopted this viewpoint, which resulted in inclusion of duty time for exercise in the NAVADMIN.

NAVADMIN 148/94 also contained changes to the body fat measurement aspects of the PRP. Prior to this NAVADMIN, all Navy personnel had their body fat assessed by circumference measurement. This was in keeping with the DoD Directive, which stated "The determining factor in deciding whether a service member is overweight is the member's percent of body fat."⁴ Height to weight tables may be used by all military services as the first line screening technique until validated body composition measurement techniques are in place servicewide." It is unclear whether BUPERS believed validated techniques were in place servicewide, but there was some feeling within BUPERS that a great deal of time was being spent on body fat assessment, and that time should be reduced. Additionally, all the other services were using weight-for-height screening tables as part of their body fat programs at this

time. The NAVADMIN called for the use of a weight-for-height table as an initial screen for body fat assessment. The weight-for-height table is provided in Table 12. The weights are the maximum weights for height contained in the table in DoD Directive 1308.1.⁴ For each of the weights for height in Table 12, the equivalent percent body fat has been estimated from height and weight using the equations developed by Hodgdon.²⁷

Remembering that the Navy body fat standards were 22% fat for men and 30% fat for women, the weight-for-height values shown in Table 12 are fairly efficient as a screening tool. The weight values, on average, approximate the body fat standards. However, the percent fat values were not uniform across heights, and the derivation of the values for the table in the DoD Directive was not known.

NAVADMIN 148/94 also provided a waiver from the body fat standards. If a service member received his/her third failure in 4 years and that failure was due to exceeding the

Table 12. Weights for Height From NAVADMIN 148/94				
<u>Height (inches)</u>	<u>Males Maximum Weight (pounds)</u>	<u>Males Estimated % Body Fat</u>	<u>Females Maximum Weight (pounds)</u>	<u>Females Estimated % Body Fat</u>
58			126	30.6
59			128	30.1
60	153	24.4	130	29.7
61	155	23.7	132	29.2
62	158	23.3	134	28.8
63	160	22.7	136	28.3
64	164	22.5	139	28.1
65	169	22.5	144	28.5
66	174	22.5	148	28.7
67	179	22.5	152	28.8
68	184	22.5	156	28.9
69	189	22.5	161	29.3
70	194	22.6	165	29.4
71	199	22.6	169	29.6
72	205	22.8	174	30.0
73	211	23.0	179	30.4
74	218	23.4	185	31.1
75	224	23.7	190	31.5
76	230	23.9	196	32.2
77	236	24.1	201	32.6
78	242	24.3	206	33.0
79	248	24.5	211	33.4
80	254	24.7	216	33.8
Mean		23.3		30.3

body fat standards, the service member could request a waiver from administrative separation or denial of reenlistment if:

- the request was submitted within 30 days of the last failure,

- the member had passed the most recent PRT (unless medically waived),
- the service member was no more than 3% fat above standards, if male, or 4% fat above standards, if female, and
- the service member submitted a package including the last 3 EVALs (if E-5 or below) and a copy of OPNAV 6110.2.

In December 1994, NAVADMIN 229/94 allowed Navy personnel who exceeded the body fat standards to apply for a “unique body structure” waiver. The intent was to provide relief from the body fat standards to those individuals whose body dimensions are such that they would be predicted as being above standards when they, in fact, were not. To qualify for the waiver, a service member must (a) show superior fitness by achieving an “Excellent” or “Outstanding” on the PRT, (b) have strong medical documentation of excellent health and physical fitness and a truly unique body structure (as determined by the authorized medical department representative) that is not due to excess body fat, and (c) have no prior attendance in a military overeaters treatment program.

DoD Directive 1308.1 (20 July 1995)

In July 1995, the Assistant SECDEF for Force Management Policy (FMP) reissued a DoD Directive with the subject DoD Physical Fitness and Body Fat program. Accompanying this release was the release of DoD Instruction 1308.3, titled “Physical Fitness and Body Fat Programs,” which contained implementing Instructions for the policies provided in the Directive. Changes in policy contained in the Directive included an increase in the maximum percent body fat allowed by service standards to new values of 26% fat for men and 36% fat for women. Service members were to have their body fat content determined if they exceeded the maximum weight on a weight-for-height table provided in the accompanying DoD Instruction. Services were still required to implement body composition programs that enhanced general health, physical fitness, and military appearance, and they were to focus on reduction in body fat rather than simple weight loss in the evaluation of the efficacy of their programs. All service members were required to have their physical fitness evaluated for the record at least annually. Service members identified with medical limitations were to be placed in physical conditioning programs consistent with their limitations, and they were still required to meet the body fat standards of their military department.

DoD Instruction 1308.3 (30 August 1995)

In late August 1995, the Instruction implementing the DoD Directive was issued. The Instruction contained a weight-for-height table based on the Metropolitan Life Insurance Tables of 1983. The table was labeled “Critical Weight Values From 1983 Metropolitan Life Insurance, 120% of Midpoint of Medium Frame Value.” The table also contained adjustments to height and weight to account for shoes and clothing, respectively. The proposal to use the Metropolitan Life Insurance tables as the basis for body fat screening grew out of a joint Army, Navy, and Marine Corps meeting of research and body fat policy representatives held at NMRDC in the summer of 1994. Because the Metropolitan tables had been the basis for the Navy body fat standards, it was felt that until a more appropriate table could be developed, a table reflecting 120% of the Metropolitan tables values would be the best available. As it turned out, the table provided to DoD did not actually contain the midpoint values for the medium frame individual as intended, but rather was calculated from a table published by Andres.³ The weights in the DoD table represent 120% of the midpoint weight (across all frame sizes) for each height in the 1983

Metropolitan tables, adjusted for added height from shoes and weight from clothing. These weights for height and their equivalent estimated body fat content values are provided in Table 13.

Service members exceeding those weight-for-height values were required to have their body fat content determined using circumference-based predictive equations. In addition to new maximum allowable values for body fat content, the Instruction also provided minimum allowable standards for percent body fat. Services were not allowed to set percent fat standards that were less than these allowable standards. The minimum allowable standards were 18% for men, and 26% for women. This allowed a range of standards that encompassed the existing standards of each of the Services at the time of the implementation of the Instruction.

Table 13. Weights for Height From DoD Instruction 1308.3				
<u>Height (inches)</u>	<u>Males Maximum Weight (pounds)</u>	<u>Males Estimated % Body Fat</u>	<u>Females Maximum Weight (pounds)</u>	<u>Females Estimated % Body Fat</u>
58			139	34.4
59			141	33.9
60			144	33.7
61	161	25.0	147	33.6
62	164	24.6	151	33.7
63	167	24.2	155	33.8
64	170	23.8	160	34.2
65	174	23.6	164	34.3
66	178	23.4	168	34.5
67	181	22.9	172	34.6
68	185	22.7	176	34.7
69	188	22.3	179	34.5
70	192	22.1	183	34.6
71	196	21.9	187	34.8
72	200	21.7		
73	205	21.7		
74	210	21.7		
75	215	21.8		
Mean value:		22.9		34.2

The Instruction contained some confusing elements, which generated later General Accounting Office (GAO) criticism of DoD policy implementation. The stated policy was that “Service members possess the cardiorespiratory endurance, muscular strength and endurance, and whole body flexibility to successfully perform in accordance with a military service-specific mission and military specialty” (para D), and that “Cardiorespiratory endurance, muscular strength, balance and agility, and explosive power, together with desirable body composition, form the basis of the DoD Physical Fitness and Body Fat Program” (para D). Yet the services were to emphasize “...programs that develop and maintain general health and physical fitness,” and were only required to “develop and utilize physical fitness tests (PFTs) that evaluate cardiovascular and muscular endurance” (para F.1.c.1).

Also, the instruction states that, “Whatever new requirements that the military Services establish, there must be a 8 to 10 percent difference between male and female standards.” Then in the sentence immediately following, it states, “Military Services shall not derive, extrapolate or adjust female standards using data from male subject or vice versa.” And, it is later stated, “The standards for one gender shall not be extrapolated from the other gender’s standard or be derived from the data base of the other gender.” Contradictory statements such as these were confusing to the Services as well as to GAO.

Navy Program Changes

Following the release of the DoD Directive and Instruction, another NAVADMIN was issued (NAVADMIN 315/95, December 1995). This NAVADMIN replaced the weight-for-height table from 1994 with that contained in the DoD Instruction (Table 13). As mentioned, this particular formulation of the Metropolitan Life tables did not exactly match that used by Hodgdon in the body fat standards development.²⁷ As a result, the average percent fat equivalents represented by the weights were not exactly equal to the values of 22% for men and 33% for women suggested by Hodgdon to be the body fat standards (Table 13).

At the time of the introduction of this screening table, a concerted effort was made to convince the OCNO that the body fat standards should represent a parallel development for both sexes. Under that argument, either the women’s body fat limit should have been raised to 33% fat, or the male standard should have been lowered to about 20% to provide the same percentage adjustment of the Metropolitan tables, or, alternatively, the same percentile of the weight distributions for the American population.³⁶ These arguments were not accepted, and this table, which was a much more lenient screening tool for women than for men, was promulgated.

Other administrative actions taken following the release of the DoD Instruction included the announcement of the release of a new Nutrition and Weight Control Self-Study Guide, Navy Personnel (NAVPERS) 15602A (NAVADMIN 282/86), the elimination of the waiver from administrative separation due to excess body fat (NAVADMIN 282/97), and the announcement of the imminent release of a new OPNAVINST 6110 (NAVADMIN 039/98, March 1998).

Research and Development

In the period following the release of OPNAVINST 6110.1D, a study was conducted to explore the use of a new criterion measure for body composition evaluation. The body fat estimation equations in use by all of the services used a determination of body fat content from two-compartment analysis of body density determined from underwater weighing. In the two-compartment analysis, the body is treated as being composed of two parts, the fat mass and the fat-free mass. The densities of each of the masses are assumed to be constant for all individuals. The body density may be apportioned between the body compartments according to the following formula:

$$\frac{1}{\text{density}_{\text{body}}} = \frac{f_1}{\text{density}_1} + \frac{f_2}{\text{density}_2}$$

where $\text{density}_{\text{body}}$ is the total body density, f_1 and f_2 are the fractions represented by compartments 1 and 2, respectively, and density_1 and density_2 are the densities for compartments 1 and 2, respectively. Since there are only two compartments, $f_2 = 1 - f_1$, and this relationship can be substituted in the above equation to yield an equation that can be solved for the f_1 . If f_1 is the fraction of fat in the body and the density of the fat compartment (density_1) is taken to be 0.9,

and the density of the fat-free compartment (density₂) is taken to be 1.1, the solution is the Siri equation provided earlier in this report. A difficulty with this approach is that the assumptions are not met. While it appears that the density of the fat compartment is relatively constant across individuals, the density of the fat-free compartment is not. The major sources of variation in the fat-free compartment density are variations in bone mineral density and variations in total body water content. The current best estimates of body fat content are those based on an analysis of body composition that involves measurement of the bone density and total body water. Such an analysis is referred to as a “four-compartment” analysis because the body density is allocated to four compartments: the fat compartment, the bone compartment, the water compartment, and the residual compartment.

Potential political difficulties are associated with the use of a two-compartment analysis as the criterion for body fat content measurement. There is a systematic difference in bone density between blacks and whites (other ethnic groups appear to fall in between average values for blacks and whites). On average, blacks have greater bone densities than whites. The result is that for a body fat equation developed on a sample of whites, the body fat content of blacks will be overestimated by about 1.5% body fat (because for the same anthropometry, blacks will be actually be less fat, on average, as a result of their greater bone density). If an equation is used that was developed on an ethnically balanced population sample, blacks will be overestimated by about 0.75% fat and whites underestimated by the same amount.

Because of these potential difficulties, NHRC, at the request of BUPERS, undertook a study to predict body composition from circumferences using a four-compartment analysis as the criterion measure. The sample for this study was balanced by gender and ethnicity: 166 male (84 white, 82 black) and 161 female (82 white, 79 black) Navy and Marine Corps active-duty personnel in the San Diego area. Results of the analysis of the data collected in this study were:

- (a) the systematic ethnic bias in percent fat estimation was found to be entirely due to the use of the two-compartment analysis as the criterion. The prediction of body fat from anthropometry does not contain ethnic differences in prediction. Ethnic differences emerge only when the results of prediction are compared with the two-compartment body fat measurement.
- (b) the measures currently in use by the Navy work as well as most other combinations of circumferences to predict body fat content from a four-compartment analysis.

The following equations were developed for the prediction of four-compartment fat from the measures currently in use by the Navy:

$$\% \text{ fat} = 85.79 \times \text{Log}_{10}(\text{adomen circ.} - \text{neck circ.}) - 62.56 \times \text{Log}_{10}(\text{height}) + 12.76$$

for men, where all measurements are in centimeters. The multiple correlation coefficient for this equation was 0.91 and the SEM was 2.75% fat. The equation developed for women was:

$$\% \text{ fat} = 135.10 \times \text{Log}_{10}(\text{waist circ.} + \text{hip circ.} - \text{neck circ.}) - 97.93 \times \text{Log}_{10}(\text{height}) - 46.65$$

where, again, the measurements are all in centimeters. The multiple correlation coefficient for this equation was 0.87, and the SEM was 3.00% fat.

Tables similar to those included in the OPNAVINSTs were developed, and the results of this study were briefed to the Physical Readiness Division in the BUPERS (PERS-601). There

followed extensive conversations with the Master Chief Petty Officer of the Navy and the Chief of Naval Personnel, each of whom believed that the current body fat standards were already too liberal. As a result, PERS-601 expressed reservations with the new equations because there were individuals whose estimated body fat content would increase by 3% fat or more. The decision was made to continue with the current Navy equations. However, there was interest in the approach of using equations validated against a four-compartment analysis by the Marine Corps and the Air Force. The Marine Corps adopted the equations for use in its Marine Corps Order 6100.10B (1 October 1997),¹⁷ which funded a study to validate the equation on Marine Corps personnel. The Air Force also provided funding for a validation of the equation on an extended sample balanced by gender and black/white ethnicity. Those studies have concluded, and the final report is being written.

OPNAVINST 6110.1E (23 March 1998)

OPNAVINST 6110.1E was signed out on 23 March 1998, to become effective on 1 September 1998. The Instruction was issued to implement some changes in the program. Training for CFCs was made mandatory. The weight-for-height screening table and upper limit for women's body fat were revised. Minor changes were made to the 1.5-mile run standards for women. New Instructions were issued for the push-up and curl-up events. Changes were made to the sit-reach event, and an exercise requirement for pregnant sailors was issued.

Qualifications of CFCs were unchanged from the previous Instruction. However, instead of being encouraged to seek ACSM certification, all CFCs were now required to attend BUPERS-approved training and receive a CFC certification from that training. Additionally, commands were encouraged to appoint departmental and divisional CFC assistants, as needed. The assistants were encouraged to receive the BUPERS-approved training whenever possible.

A new weight-for-height table was provided in OPNAVINST 6110.1E to serve as the initial body fat screen. This table was developed using Hodgdon's equation for estimation of body fat content from weight and height.²⁷ Weights were calculated for each height that were equivalent to 22% fat for men and 33% fat for women. The previous standard of 22% fat for men was retained, but the standard for women was changed to 33% so that it was equivalent to the standard for men in terms of its derivation.

At the request of the Chief, NAVPERS, the standards for the 1.5-mile run were investigated. The CNO had expressed concern at the difference between the run times required of young women and those of young men. He was of the opinion that gender difference should not be as great as it was for the "Excellent," "Good," and "Satisfactory" categories for the two youngest age groups. Although the CNO's concerns were specific to graduation requirements for Recruit Training (at Recruit Training, Great Lakes, the "Good" category of the Navy's PRT standards are used as their graduation requirement), PERS-601 was directed to make changes to the PRT instruction to address the CNO's concern. Table 14 shows the difference in run times between men and women in the standards provided in OPNAVINST 6110.1D. The differences shown are the times for women minus the times for men and are expressed in minutes. NHRC undertook an analysis of the run times to determine whether there might be a basis for decreasing the difference between male and female run times.

The approach taken was to express the run times as VO_{2max} equivalents, using a formula developed by Beckett and Hodgdon.⁵ The women's VO_{2max} equivalents for each PRT classification and age group were expressed as a fraction of the male value for the equivalent classification and age group. Values were found to vary between 73% and 87% of the male

values. The mean percentage for all age and classification groups was 82% (standard deviation = 4.7% of male VO_{2max}). A decision was made to standardize the women's times at 82% of equivalent male VO_{2max} . The equivalent times are shown in Table 15. All times are rounded down to the nearest 0.25 min (15 s), as was done in the development of the OPNAVINST standards. Differences between these times and those that were contained in OPNAVINST 6110.1D are shown in Table 16.

Table 14. Difference in Run Times Between Men and Women in OPNAVINST 6110.1D					
Age Group:	17–19 years	20–29 years	30–39 years	40–49 years	50 years & older
<u>Classification</u>					
Outstanding	2.50	2.25	2.00	2.00	2.00
Excellent	3.50	3.00	2.00	2.00	2.25
Good	4.00	3.00	1.75	1.75	1.50
Satisfactory	3.50	3.00	1.75	1.75	2.00

Table 15. 1.5-Mile Run Times Equivalent to 82% of Male VO_{2max} (min)					
Age Group:	17–19 years	20–29 years	30–39 years	40–49 years	50 years & older
<u>Classification</u>					
Outstanding	12.00	12.25	12.75	13.00	13.25
Excellent	12.50	13.25	14.25	14.50	14.75
Good	13.50	14.50	15.75	16.50	17.00
Satisfactory	15.00	15.75	17.25	18.00	18.50

The values in Table 16 show that this procedure reduced the differences in the 6 times that were of particular concern to the CNO. However, applying the 82% formula to all the women's run times meant that approximately one half of the times needed to be increased. Because this was a period during which CNO (and MCPON) desired to tighten rather than relax physical readiness standards, the Physical Readiness Program office (PERS-601) was reluctant to allow slower performances on the run. PERS-601 recommended to CNO that the times for the last three categories of the youngest two age groups be adjusted downward by the amounts shown in Table 16 in bold. Other times were not changed from the values they had in OPNAVINST 6110.1D. NHRC and PERS-601 recognized that the method of deriving these changes was at variance with the DoD Instruction 1308.1. Institution of these changes and the method of their derivation were cause for comment by GAO in their review of the Service's physical fitness standards.²⁶

Minor changes to the Instructions for the curl-up and push-up were promulgated with this Instruction. During curl-ups, the buttocks are to remain in contact with the deck during the entire test and elbows are to touch the "upper thigh" (meaning while in the curl-up position, the part of the thigh between the knee and halfway between the knee and hip crease). During push-ups, members are to touch the "lower edge of the shoulder blade" to the deck. The Instructions for the sit-reach were modified to clarify the fact that three tries to reach the toes are allowed, and that the service member need only reach his/her toes on one of those tries. A failure of the sit-reach would no longer constitute a failure of the entire PRT cycle. Service members who cannot

reach their toes are enrolled in the command-directed Physical Conditioning program. This was done, again at the suggestion of the Fleet. Although it was reported that large numbers of Sailors weren't flexible enough to touch their toes, very few commands perceived it as "serious enough" to constitute a failure of the entire PRT, so that section of the test was essentially being reported as "passed," irrespective of actual performance. If failing the sit-reach was not a PRT failure, but only required remedial attention, then it would be more likely that the problem would be addressed and remedied--the intended goal of the PRT. Finally, language was added to the Instruction clarifying situations in which the service member might not take the PRT (e.g., member on travel or newly on board a command, member attending a service school of less than 10 weeks' duration) without prejudice toward the service member.

Table 16. Differences Between 82% VO₂_{max} Run Times and 6110.1D Standards (min)					
Age Group:	17–19 years	20–29 years	30–39 years	40–49 years	50 years & older
<u>Classification</u>					
Outstanding	0.50	0.75	0.75	0.75	0.50
Excellent	-0.75	-0.25	0.50	0.25	0.00
Good	-1.50	-0.50	0.25	0.25	0.25
Satisfactory	-1.25	-1.00	0.00	-0.25	-0.50

At the time of the release of OPNAVINST 6110.1E, two other efforts were coming to a close that have important implications for the next physical readiness Instruction. The Institute of Medicine concluded its studies of the relationships of body composition, nutrition and health to the readiness of military women, and the GAO concluded its study of gender issues with respect to the validity and equity of fitness standards among the armed services.

Institute of Medicine Report

In 1994, as part of the Defense Women's Health Research Program, the Committee on Military Nutrition Research (CMNR) of the Food and Nutrition Board of the Institute of Medicine within the National Academy of Sciences was asked to review existing military policies governing body composition and fitness, postpartum return-to-duty standards, Military Recommended Dietary Allowances, and physical activity and nutritional practices of military women to determine their impact on the health, fitness, and readiness of women. Particular interest was focused on whether the body composition and appearance standards for women were in conflict with body composition requirements for military task performance, or if they might interfere with readiness by encouraging chronic dieting and/or inadequate nutrition intake. A subcommittee of CMNR was formed to look into these issues. The subcommittee was designated the Committee on Body Composition, Nutrition, and Health of Military Women (BCNH) and held several focus meetings and workshops. In 1998, the BCNH released its final report.³⁴

BCNH noted that the services differ in their weight-for-height screening tables for body composition assessment, as well as in the methodologies used for body fat content assessment and the body fat standards for female personnel. They also noted that none of the service's body fat equations had been validated on postpartum women. They found evidence that chronic dieting or crash dieting to meet weight or body fat standards may compromise women's

nutritional status or fitness levels. Based on a review of available literature, they concluded that the healthy range of weights for women and men were those representing BMI (weight-for-height expressed in $\text{kg}\cdot\text{m}^{-2}$) values between 19 and 25.⁴⁵

To meet the goals of preserving adequate military readiness, and maintaining a healthy body fat content level, BCNH recommended a two-tiered approach to setting body fat standards. The first tier would be the measurement of BMI and performance of the services' PFT. If the BMI fell between 19 and 25 (irrespective of age) and the service member passed the fitness test, the member would be considered ready for duty. Service members with BMI values less than 19 are referred for nutritional counseling and physical conditioning. Service members whose BMI values exceeded 25 would be referred for a body fat content assessment. Those so referred who were found to have body fat content values of 36% of weight or less and who passed the PFT would be considered ready for duty. Those with greater body fat percentages would be referred for weight management and/or physical conditioning programs. The BCNH also recommended the development of a single servicewide equation for the assessment of body fat content. They recommended that this equation be circumference based and validated against a four-compartment analysis of body composition.

In the area of physical fitness, BCNH recommended increasing emphasis on general fitness for health and readiness by enforcing regular participation in a fitness program based on ACSM recommendations (3 days·week⁻¹, of endurance exercise at 60% to 80% of maximum capacity for 20 to 60 min and 2 days·week⁻¹ of resistance training using all of the major muscle groups at 85% of one repetition maximum).² The committee further recommended that task-specific, gender-neutral strength and endurance tests and standards be developed for use in selection and retention in jobs that require moderate to heavy lifting. Specialized training programs should also be developed to maintain proficiency for such high-demand jobs. BCNH also determined that the current appearance standard did not appear to be linked to performance fitness, nutrition, or health. They recommended development of an objective method of assessing military appearance, if the services deemed such an appraisal necessary.

GAO Report (November 1998)

In November 1998, just 2 months after OPNAVINST 6110.1E became effective, the GAO completed a study of gender issues related to the validity and equity of fitness standards and published its final report.²⁶ This report was critical of DoD procedures in administration of its Physical Fitness and Body Fat Program, and of the services in their implementation of DoD policy. The authors of the report found the DoD policy confusing because there were several different goals for the program (general health and fitness, job readiness, and military appearance), accompanied by no guidance as to relative importance of or approaches to meet these goals. They also noted that conflicting statements in the DoD guidance contributed to confusion about DoD objectives. GAO also found DoD oversight of the physical fitness program to be inadequate.

The GAO authors found a lack of uniformity in the tests used by the services to measure physical fitness, in the level of difficulty represented by standards among the services, and in the degree of adjustment made in fitness standards for gender and age. In addition, the lack of a consistent methodology for screening by weight-for-height and the measurement of body fat and the lack of agreement on standards for body fat content were highlighted. The latter point was an issue since all of the services maintained that their body fat standards were based on health.

GAO also noted that the services' body composition equations were based on an outmoded criterion measure.

The Navy was criticized because it did not test service members 50 years of age and older, despite a clear requirement from DoD to do so. It was also criticized for the way that it made adjustments to the run-time standards for women. A single, rational method was not employed.

The GAO recommendations were that the SECDEF revise the DoD physical fitness regulations to:

- clearly state that the objective of the military physical fitness program is to enhance general fitness and health, and not to address the capability to perform specific jobs or missions;
- establish a clear DoD-wide policy for age- and gender-based adjustments to fitness and body fat standards, requiring all services to derive them scientifically, clearly document the basis used, and submit exceptions for approval;
- establish a DoD-wide approach, based on current scientific research, for estimating body fat percentages;
- establish a mechanism for providing policy and research coordination of the military services' physical fitness and body fat programs; and
- define the statistical information needed to monitor fitness trends and ensure program effectiveness, and require that this information be maintained by all services and provided in the currently required annual reports.

GAO also recommended that the SECDEF take steps to ensure that the services implement the existing requirements that:

- personnel be tested in all three areas cited in the regulation – cardiovascular endurance, muscular strength and endurance, and body composition; and
- all service members, regardless of age, be tested for physical fitness.

The GAO report was circulated in draft form to each of the services as well as to the SECDEF. The services and DoD (through the SECDEF) concurred with the findings of the report and indicated that the recommendations would be adopted.

Continuing Efforts

Research and Development

Because of the desire on the part of the CNO to increase standards of performance on the PRT, PERS-601 tasked NHRC to collect a large sample of PRT performance data from Navy commands and to evaluate the need for new standards based on the distributions of scores on the PRT and its test items. In April 1998, a message was sent out to all Navy commands directing them to forward their PRT and body fat data from their most recent PRT to NHRC (NAVADMIN 078/98). (In July 1998, BUPERS moved operations from Washington, DC to Millington TN. Soon after that, the name was changed to Navy Personnel Command [NPC], and "PERS-codes" became "NPC-codes").

The NHRC received PRT results from approximately 1,775 Navy commands, containing PRT item scores for tests conducted in late 1997 and early 1998 on approximately 220,000 Navy military personnel. Even now, not all of these records have been entered into the NHRC PRT

database. Analysis was carried out on a subset of 98,954 records, representing 709 commands that were entered into the data set as of January 1999. Records that were complete and valid PRT data and included only those personnel 49 years of age or less were selected for analysis. Those 50 years of age and older were excluded from the analysis because such personnel voluntarily elect to take the PRT and may not be representative of the total Navy population in this age group. The final data set totaled 73,595 personnel, 65,307 men and 8,288 women. These records were used to generate performance percentiles for each readiness test item for each age by gender group. Provisional standards were suggested based on use of the 90th percentile as the lower limit of “Outstanding” (except for the run and swim, where the 95th percentile was used), the 75th percentile range as the lower limit for “Excellent,” the 25th percentile as the lower limit of “Good,” and the 10th percentile as the lower limit of “Satisfactory.” The percentile values selected for the provisional standards did not match those selected for the generation of standards for OPNAVINST 6110.1C because the documentation of the procedures for generation of the previous standards had not been located when the provisional standards were developed.

Because there were extant PRT standards, personnel would perform to match “meaningful” limits (e.g., the achievement of a particular classification cut-off, or achievement of an even 5 or 10 push-ups or curl-ups). The result was that distributions of PRT-item performances were abnormal, often skewed, and/or truncated. In situations where the distributions were extremely abnormal, “adjusted” distributions based on the assumption of symmetry about the median were created using the percentile values less than the median to estimate their counterparts above the median. Standards for personnel 50 years of age and older were estimated from trend lines constructed through equivalent percentiles from the distributions observed in the younger age groups. Point scales for each event were developed in the following fashion: A performance value 10% greater than the greatest value encountered for the lower limit of “Outstanding” among all age/gender groups was assigned a value of 100 points. The least value encountered for “Satisfactory” among all age/gender groups was assigned a value of 20 points. Linear point scales using these two anchor points were then developed. The findings from the analysis of these data were provided to Commander, NPC-60 by letter report.²¹

In 1997, it was recognized in PERS-601 that the data that the physical readiness Instruction required to be provided to BUPERS was inadequate to evaluate the PRP. There was poor compliance with the requirement to provide data, and the data that were requested were not detailed or comprehensive enough to allow the state of readiness in the Navy to be determined, let alone assess trends in readiness. Discussions began with NHRC to develop a centralized database of Navy PRT data. As a first step in this process, NHRC was tasked late in FY98 to develop PRT information management software that could be used at the command level to record and maintain PRP information.

Software was developed jointly by NHRC and the Space and Naval Warfare Systems Center. The software was developed using Microsoft ACCESS[™]. The software allows entry of all PRT screening information (including both medical and nonmedical waivers), height, weight, and circumference information (if needed), as well as PRT scores. The program calculates body fat (if appropriate), scores and classifications for the PRT items and for the test overall. The information is stored as an ACCESS database, and it can be used to generate a variety of reports. The software has provisions to export and import records for personnel to allow transfer between commands as personnel move. The software was delivered to NMPC-60 in April 1999.

However, by this time, NMPC-60 was already planning the release of a new physical readiness Instruction, and the software was not distributed.

A project is underway currently at NHRC to build a prototype PRT database using the data provided as part of the PRT survey research, and to begin to build the design specifications for the database to support the information queries needed by NPC and fleet users.

Other efforts completed during this period included a BUMED-funded study of relationships between physical job demands and on-the-job injuries. Vickers and Hervig showed that the prevalence of lower back and musculoskeletal injuries increase with the value of rating of physical job demands.^{46,47} One implication of this work is that reduction of injuries in high physical job demands may require increased strength levels for those working in such jobs.

Draft DoD Instruction 1308.3

The Assistant SECDEF for FMP is currently drafting a new DoD Instruction 1308.3 covering DoD Physical Fitness and Body Fat Program procedures. This effort had begun prior to the release of either the Institute of Medicine or GAO reports, but it was drafted with full knowledge of the ongoing studies that led to those reports. In its current form, it addresses most of the GAO recommendations.

Physical fitness. As policy, the draft Instruction states “Aerobic capacity, muscular strength and muscular power, together with desirable body fat percentage, form the basis of the DoD Physical Fitness and Body Fat Program.” This wording represents a change from previous wording that tended to combine muscular strength and muscular power as a single ability, and that also included flexibility, balance, agility, and explosive power as abilities to be developed under the physical fitness program. The draft directs the military services to “design physical fitness training and related physical activities that enhance both general health and physical fitness which, in turn, promotes combat readiness...” The services are also directed to “extend their physical fitness programs to incorporate occupational-specific physical fitness requirements for those career fields where it is deemed necessary to ensure adequate performance and safety.” Services are also required to incorporate a health promotion program and cardiac risk-factor screening within their fitness programs. All service members, regardless of age, are to be tested for physical fitness, and service members may be authorized to use duty time for physical fitness training.

In response to the GAO recommendation, the military services will be required to establish an automated data repository. This repository is to provide initial or baseline statistics and a tracking mechanism that monitors physical fitness and body weight/body fat results by age, gender, rank, and military occupational specialty, including remedial actions taken and information on discharges resulting from physical fitness and/or body fat failures.

Body fat. The draft Instruction calls for use of body fat content as a percent of body weight as the determining factor in deciding whether a service member is overfat. Body fat content is to be determined by a circumference-based measurement method. The services are to screen members initially using a weight-for-height screening table. That table is not to be more stringent than the national recommendations for healthy weights (i.e., BMI values ≥ 19 and ≤ 25). Gender-appropriate body fat limits are to be used. These limits will not be more stringent than 20% for men and 30% for women.

These upper limits represent a departure from the procedures discussed in the meetings that were held to draft body fat policy. In those meetings, a set of standards based on the approach presented in the Institute of Medicine report were proposed by the ad hoc research working

group.³³ Men with body fat content values less than 20% body weight and women with values less than 30% body weight would be considered within standards. Men with values greater than 20% fat, but less than or equal to 26% fat would be in a “cautionary zone,” and acceptability of their body fat content would depend on performance on the service’s PFT. For women, the cautionary zone would be 30% to 36% fat.

The DoD has adopted a slight reformulation of the current Navy/Air Force equation as the method to be used in body fat estimation. The equations developed for the Navy were formulated to predict body density. The Siri equation was used to convert estimated body density to percent body fat. These equations have been reformulated to predict percent fat directly. The equations are:

Males:

% body fat = 86.010 X Log₁₀(abdomen circ. – neck circ.) - 70.041 X Log₁₀(height) + 36.76
(N = 594, R = 0.903, SEE = 3.52 % fat)

Females:

% body fat = 163.205 X Log₁₀(waist circ. + hip circ. – neck circ.) - 97.684 X Log₁₀(height) - 78.387
(N = 202, R = 0.856, SEE = 3.61 % fat)

where all of the measurements are in inches. The Instruction provides lookup tables for percent fat as a function of height and the sum of circumferences. These tables are virtually identical to those in use by the Navy and Air Force today. The process leading to the adoption of this equation is reported in Hodgdon and Friedl.³³

Joint Service Working Group. The draft Instruction calls for the creation of a Joint Service Working Group (JSWG) to “provide policy and research coordination among DoD components, military services, and health agencies and organizations.” The specific duties of the JSWG include coordination of biomedical research findings into policy recommendations for the military services’ physical fitness and body fat programs. Membership on the JSWG will include key DoD and military services researchers. The membership will be expanded to include representatives of outside fitness schools/centers and other institutions and academia, as needed for specific tasks. This working group is similar in composition and tasking to the DoD CPF that was created in 1981, after the issuance of DoD Directive 1308.1 of that year. That committee was not mandated by Instruction, and it stopped meeting after 3 years or so.

Navy Activities

At this time, the Navy is reviewing its policy with respect to physical readiness. A new OPNAVINST 6110 is being drafted. As part of drafting this new Instruction, it appears a great deal of thought is being directed toward the basis for and implementation of physical readiness standards. The Navy does not yet know the final form of the DoD guidance and the implications they may have for Navy policy (although, based on the current DoD draft, the only major change in current policy that would be required is the testing of all personnel, irrespective of age). Until the issues surrounding physical readiness policy are resolved, a moratorium on separations from the Navy due to consecutive PRT or body fat failures has been enacted (NAVADMIN 012/99).

CLOSING REMARKS

The adoption of the responsibility for the Physical Fitness and Body Fat Policy by the OCNO has led to the promulgation of a series of Instructions, the intent of which was the improvement of the health and physical readiness of Navy personnel. Certainly, the most recent evaluation of the fitness of the Fleet suggests the Instructions have been successful, at least with respect to health-related physical fitness. Figure 2 shows a comparison of the percentiles for the 1.5-mile

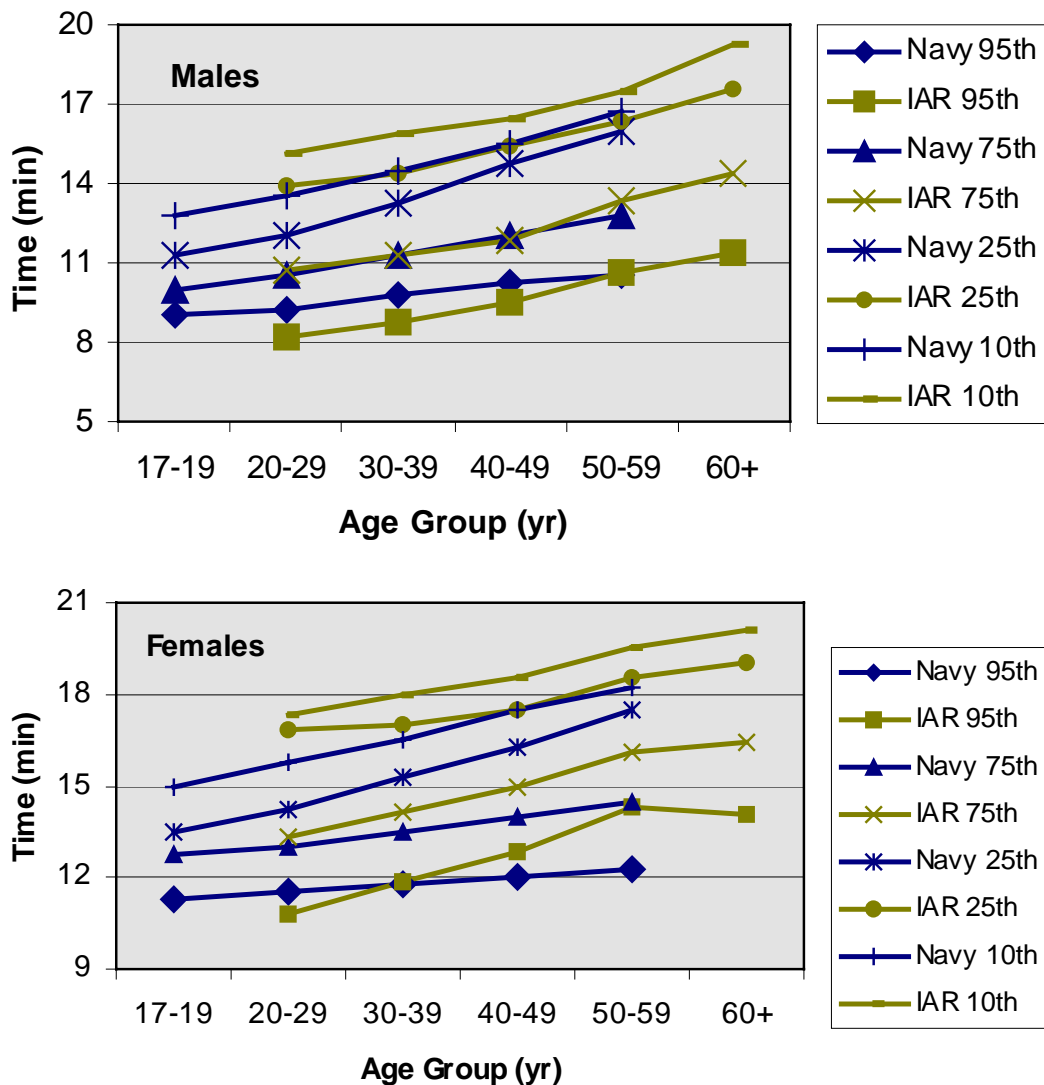


Figure 2. Comparison of 1.5-mile run times for Navy and Institute of Aerobics Research (IAR) population samples.

run time from the Navy 1997/1998 sample, with equivalent percentiles for the population sample from the Institute for Aerobics Research (IAR). The values for men are shown in the upper panel and those for women in the lower panel. Several things are noteworthy in this figure: The run times for the most-fit Navy personnel are similar to those of the most-fit individuals in the

IAR sample. The run times for the less-fit individuals in the Navy sample are less than their counterparts in the IAR sample. There is a suggestion that the rate of increase in run time with age is less for the most-fit Navy personnel (the 95th and 75th percentiles) than it is for the most-fit individuals in the IAR sample. Similar analyses are not possible for the other PRT items.

It is recognized that the IAR sample is not representative of the U.S. population. This sample does represent an extensively studied segment of that population, a segment that has been used to generate fitness recommendations for the nation,² and a segment that is more likely to be made up of affluent, more healthy, individuals than of poorer, less healthy ones. The 1.5-mile run time is an indicator of aerobic fitness. Aerobic fitness has been shown to be related to long-term health. The results shown in Figure 2 suggest that the existence of a physical conditioning and testing program by the Navy is helping to maintain greater levels of health-related fitness than would be expected in the U.S. population. This positive aspect of the program is expected to continue or be enhanced with subsequent Instructions in this series.

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13. ABSTRACT (Maximum 200 words) This report reviews the development, evolution, and implementation of the Navy's physical readiness program through the 6110.1 series of instructions issued by the Office of the Chief of Naval Operations (OPNAVINST). The first of these instructions, OPNAVINST 6110.1 was issued in 1976 and emphasized a program of cardiovascular-respiratory fitness based on the popular "aerobics" program of Dr. Cooper. OPNAVINST 6110.1A was issued in 1980, following a presidential request for an assessment of the Services' physical fitness. The only change from the previous instruction was the inclusion of a physical fitness test. A comprehensive revision of the program was issued in 1982 as OPNAVINST 6110.1B. The instruction included a three-level program named "physical readiness", and included consideration of physical fitness, weight control, and health promotion issues. A physical readiness test (PRT) was included consisting of measurement of the time required to run 1.5 miles, or the number of steps-in-place which could be done in 3 minutes; measurement of the number of curl-ups which could be done in two minutes, and measurement of the sit-reach distance. OPNAVINST 6110.1C of 1986 added items to the PRT, and established the basis for policy and practice that has continued to this day, with minor revisions.				
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